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Breeding and Genetics

M1 The impact of herd opportunity and milk recording periods in estimating lifetime net income. E. Yook*, R. E. Pearson, and B. G. Cassell, *Virginia Tech, Blacksburg.*

The Purpose of this study was to determine how well estimators of lifetime net income based on 305 lactation yields and a ten year opportunity (RNI305.10) and based on complete lactation data but a five year opportunity (RNIc.5) predict the estimate based on complete lactations and a ten year opportunity (RNIc.10). Previous studies have used shorter (five year and seven year) opportunity periods and only production through 305-d to estimate a cow's lifetime net income. Records for 22,854 cows in Virginia herds born in 1988, 1990, and 1992 from the Dairy Records Management Systems (DRMS) in Raleigh, North Carolina were used. The relative net income (RNI) function included total milk, fat, and protein income - feed cost for production + net value of calves + net cull value - rearing cost - ((daily cost for labor, maintenance feed, supplies, and fixed expenses) × days in herd). Each RNI was calculated using milk-fat-protein pricing. A cow's RNIc.10 was calculated using all production initiated prior to her tenth birthday. All lactations initiated prior to her fifth birthday were used to calculate a cow's RNIc.5. We calculated an RNI305.10 using only milk produced during the first 305-d of every lactation initiated prior to tenth birthday. Total milk, fat, and protein based on c.5 were 20845kg, 737kg, and 666kg; those based on c.10 were 28539kg, 1009kg, and 905kg; finally, those based on 305.10 were 25304kg, 883kg, and 792kg. The means of RNIc.5, RNIc.10, and RNI305.10 were \$1445, \$2279, and \$1857, respectively. Regression analyses including herd and birth year in the model were used to estimate the regression of RNIc.10 on RNIc.5, and RNIc.10 on RNI305.10. The resulting regression coefficients were \$1.52 and \$1.14 explaining 68% and 96% of the variation of RNIc.10. Using RNIc.10 as the measure to estimate lifetime profit is strongly recommended over the two alternatives tested.

Key Words: Lifetime Net Income, Relative Net Income, Herdlife Opportunity

M2 Genotype by environment interactions in the association among milk yield, age and body weight at first calving in Holstein cows. R. Ruiz-Sánchez¹, H. Castro-Gómez², F. Sánchez y GF¹, and H. Castillo-Juarez*¹, ¹Universidad Autónoma Metropolitana, Unidad Xochimilco, ²Universidad Nacional Autónoma de México.

This study evaluated the effect of herd environment on the genetic and phenotypic relationships of milk yield (MEM) on age (AFC) and body weight at first calving (BW) in primiparous Holstein cows. Data analyzed were 248,230 first parity records of Holstein cows calving from 1987 to 1994, daughters of 588 sires in 3,042 herds in the US. Herds were classified into low and high environment classes. Genetic parameters were estimated with bivariate linear mixed models using the multiple trait derivative free software (MTDFREML). Heritability for AFC and BW were 0.33 ± 0.01 and 0.07 ± 0.01 in high environment herds and 0.20 ± 0.01 and 0.07 ± 0.01 in low environment herds respectively. Genetic correlations between MEM and AFC were -0.52 ± 0.02 and -0.31 ± 0.03 in high and low environment classes, whereas between MEM and BW in both classes were similar (-0.19 ± 0.06 and -0.21 ± 0.06 , respectively). Correlated responses estimated per 1000 kg of genetic gain in MEM for high and low herd environment classes were -22.1 and -19.3 days for AFC and -0.81 and -0.41 kg BW, respectively. BW information, as provided by AIPL (USDA) is inaccurate. Hence, results related to this trait are not conclusive. Different values of heritability for AFC, as well as changes in the genetic correlation between MEM and AFC across environments, indicated genotypic by environment interaction. Thus selection for MEM correlates with reduced AFC, but expected correlated response changes across environments.

Key Words: Genotype by Environment Interaction, Age at First Calving, Genetic Parameters

M3 Heritability of body weight at 130 days from hatching in the Pacific white shrimp (*Litopenaeus vannamei*) using an animal model. H. Castillo-Juarez*, *Universidad Autónoma Metropolitana, Unidad Xochimilco.*

To estimate the heritability of body weight (BW) in the Pacific white shrimp, *Litopenaeus vannamei*, an experiment was conducted using 101 families in two commercial units of a Mexican hatchery and two prawn

population densities (9.1/m² and 14.8/m²). These 101 families consisted of 17296 prawns, sibs from 51 sires and 101 dams. Prawns were injected with a colored, elastomer tag to identify families, which allowed mixing of families for performance evaluation. Prawns were individually weighted at an average of 130 days from hatching. Small differences in days from hatching were related to management practices. BW family phenotypic mean (s.d) was 18.2 g (2.3), ranging from 15.6 to 22.5 g. Females were 0.5 g heavier than males. Breeding values were calculated for all prawns using mixed model methodology with an animal model and MTDFREML software. The model included fixed effects of days from hatching and sex, plus commercial unit, population density and the animal additive genetic effect as random effects. BW heritability was 0.57. Since genetic selection in shrimp industry is based on family selection, families were ranked using BW phenotypic means, BW least square means and BW breeding value means. The rank correlation between family phenotypic means and family breeding value means was 0.64, and between least square means and breeding value means was 0.87. BW family breeding value means ranked from -1.921 to 3.527 g. Family breeding value means allow to better select families and apply different selection intensities within family to increase genetic gain in an optimal way.

Key Words: Shrimp, Genetic Parameters, Animal Model

M4 Merit of obtaining genetic evaluations of milk yield for each parity on Holstein bulls. H. D. Norman, J. R. Wright*, R. L. Powell, and P. M. VanRaden, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Modeling separate Predicted Transmitting Abilities (PTA) for each parity is becoming more frequent internationally. A concern when using a single trait genetic evaluation model is that changes in PTAs could be larger than expected for bulls whose daughters deviate considerably from the typical response due to aging. The objective of this research was to examine how difference in rate of maturity of bulls daughters impacts changes in bull evaluations across time. The 305-d milk records for Holsteins first calving between 1960 and 1998 were used to calculate 12 tailored PTAs for each bull. Tailored PTAs (controlled by parity combinations and run dates) were calculated for 1996 to 1999 run years using records of cows first calving prior to each January. Four annual evaluations included only first lactations on daughters and contemporaries (PTA₁). Four more included the first two lactations available (PTA₁₋₂), and the last four included the first three lactations (PTA₁₋₃). The three PTAs (different parities) for each year included cows first calving by the same cutoff date. Tailored PTAs had more uniformity across years in mean records/daughter than published PTAs. Stability (absolute differences, standard deviations (SD) of differences, and correlations between bull evaluations) across time was compared. Bulls born after 1984 having ≥500 daughters were examined because of their high precision and recent activity. SD of bull differences in PTA₁, PTA₁₋₂, and PTA₁₋₃ for milk between 1996 and 1997 were 28, 28, and 27 kg compared to 63 kg for the published evaluations. Similarly, SD between 1996 and 1999 were 36, 32, 32, and 79 kg, respectively. PTA₁₋₂ was usually intermediate to PTA₁ and PTA₁₋₃ for any bull having a large difference between PTA₁ and PTA₁₋₃. Results suggest that modification of the current evaluation model should reduce fluctuations in PTAs for individual bulls across time and should also improve the accuracy of evaluations.

Key Words: Milk Yield, Parity, Lactation Number

M5 Joint genetic evaluation of male and female fertility using longitudinal binary responses. R. Rekaya and T. Averill*, *Department of Animal and Dairy Science, University of Georgia, Athens.*

The improvement or at least the maintenance of herd fertility has become a major objective in several genetic improvement programs worldwide. Several types of responses are used in fertility evaluation including binary, count and continuous traits. Consequently, different models and methodologies used to analyze reproductive performances. Independently of the trait or methodology used not all sources of variation are accounted for making a joint evaluation of male and female fertility unfeasible. However, a longitudinal model that accounts for all breeding events makes a better use of available information and allows for joint

evaluation of males and females. Furthermore, as a by product of longitudinal analysis, several new selection criteria could be computed and used rather than the single breeding value. In this study, insemination records from dairy herds in California, generated between 2002 and 2003 and provided by AgriTech Analytics were used. After editing, the data consisted of a total of 369,353 insemination records with an average of 1.76 inseminations per cow. A random regression model at the liability scale was used to model the success (failure) of insemination events. The models included herd-year, technician and month of insemination as fixed effects and service sire, quadratic regression on days of milk, permanent environmental effects and residual terms as random effects. The heritability of success of insemination increased slightly with days in milk and ranged between 0.04 -0.055. The service sires and permanent effects variances were 0.01 and 0.012 respectively. Although small, these estimates are within the range of reported estimates for reproductive traits and indicate the possibility of improvement of male and female fertility through selection. Several new selection criteria such as the probability of conception after first insemination, after 3 insemination or the probability of no conception after a number of days were computed and can be used for selection decisions.

Key Words: Fertility, Male, Female

M6 Evaluation of net energy efficiency for lactation and economic performance as selection criteria in dairy cattle. P. Zamani*¹, S. R. Miraei Ashtiani¹, A. Naserian², A. Nik Khah¹, and M. Moradi Shahrabak¹, ¹*Department of Animal Science, Faculty of Agriculture, University of Tehran, Karaj, Iran,* ²*Department of Animal Science, Faculty of Agriculture, University of Ferdowsi, Mashhad, Iran.*

Improvement of feed efficiency and related economic performance is of great importance in dairy farming. This study was conducted to evaluate the net energy efficiency and economic performance of lactation as selection criteria for dairy cattle. 2589 monthly records collected from 723 lactating cows in 3 dairy farms were analyzed for the mentioned purpose. Different usages of energy were estimated, using National Research Council (NRC) models. A multivariate animal model including fix effects of herd-year-season, parity number and lactation stage, and random effects of animal genetic and permanent environment was adopted for estimation of genetic and phenotypic parameters, using Derivative Free approach of Restricted Maximum Likelihood (DFREML). Heritability estimates of milk yield, 3.2 percent fat corrected milk, net energy efficiency, gross income and variable profit, were 0.30, 0.31, 0.32, 0.34, 0.24 and 0.29 respectively. The results of this study showed that, the genetic factors considerably contribute to the feed efficiency and economic performance of lactating cows. However if measuring the feed efficiency is not feasible, considering 3.2 percent fat corrected milk in selection index may be an effective way for indirect selection and improvement of feed efficiency and economic performance in dairy cows.

Key Words: Dairy Cattle, Net Energy Efficiency, Fat Corrected Milk

M7 Estimates and relationships of growth curve parameters in NDama cattle. O. Mgbere^{1,2}, I. Imumorin*³, O. Olutogun¹, and A. R. Abdullah¹, ¹*Dept of Animal Science, University of Ibadan, Ibadan, Nigeria,* ²*Dept of Animal Science, Rivers State University of Science & Technology,* ³*Dept of Biology, Valdosta State University.*

Weight-age records of purebred NDama, a West African taurine beef cattle breed, were used to estimate growth curve parameters based on non-linear regression models of Brody, Von Bertalanffy and Richards and phenotypic relationships of the parameter estimates within each model. Records covered from birth to 69 months of age for 549 males and up to 84 months for 670 females accumulated over a 16-yr period at Fashola Cattle ranch in Oyo, Nigeria. Least squares estimates of asymptotic weight (A) from the models ranged from 386 ± 9.8 kg and 254 ± 4.6 kg in Von Bertalanffys function (model II) to 441 ± 33.2 kg and 273 ± 10.6 kg in Richards function (Model III) for NDama bulls and cows with a corresponding average maturing rate (K) of 0.032 and 0.044 kg.kg⁻¹.Mo⁻¹, respectively. Values of A and K for the breed average from the models were essentially intermediate between the two sexes. Estimates of integration constant (B) for the groups ranged from 0.46 ± 0.03 to 0.98 ± 0.02, while estimates of shape parameter (M) provided for only in Richards model were 0.91 ± 0.16, 0.68 ± 0.11 and 1.09 ± 0.38 for

Ndama males, females and breed average, respectively. The phenotypic relationship between A and K in the models were highly negative ($r_p = -0.76$ to -0.98), indicating that genetic selection for early maturity would lead to small mature weights and vice versa in NDama cattle. With minor exceptions involving Richards model, the pattern of relationships followed similar trends indicating that growth curve parameters in the different models measured similar growth characteristics. We show that growth curve parameters, their relationships and biological implications can improve our understanding of the growth and development pattern of NDama cattle under various production environments in the tropics.

Key Words: Non-Linear Models, Growth Curves, Cattle

M8 Analysis of daughter pregnancy rates and estimated relative conception rates for a bimodal distribution. H. N. Schlessner^{*1}, R. D. Shanks¹, S. L. Rodriguez-Zas¹, J. S. Clay², P. M. VanRaden³, P. J. Berger⁴, and M. H. Healey⁴, ¹University of Illinois Urbana-Champaign, ²Dairy Records Management Systems, ³Animal Improvement Programs Laboratory, ⁴Iowa State University, Ames.

The objective of this research was to determine whether daughter pregnancy rates (DPR) and estimated relative conception rates (ERCR) have a bimodal distribution for certain bulls as seen with perinatal survival. Perinatal survival rates were computed for 12,034 sons at Iowa State University. AIPL calculated DPRs for 48,117 sons. One hundred and seventy six bulls with a minimum of 50 sons had DPRs. Dairy Records Management Systems computed ERCRs for 3,276 sons from breedings in 1988 through 1997. Seventeen bulls had at least 50 sons with ERCRs and were included in the analysis. A kernel density procedure estimated density of DPR and ERCR for each bull. Three different bandwidth multipliers were used (1,2,3). Densities that were bimodal at bandwidth multiplier one but fail to remain bimodal at bandwidth multiplier two were considered unimodal. None of the bulls were bimodal for DPR or ERCR. Of the 21 bulls that were bimodal for perinatal survival, all 21 had DPRs but only five had ERCRs. A significant ($P < 0.0001$) correlation of 0.134 between DPR and perinatal survival (8552 sons) was found. This positive correlation indicates that bulls with higher DPR tend to have higher perinatal survival. The correlations between DPR with ERCR for 1996 (1346 sons) and DPR with ERCR for 1997 (1611 sons) were not significant, nor were the correlations between perinatal survival with ERCR for 1996 (463 sons) and perinatal survival with ERCR for 1997 (414 sons). A significant ($P < 0.0001$) correlation of 0.361 between ERCR for 1996 and ERCR for 1997 (541 sons) was found. From this research we conclude that daughter pregnancy rates and estimated relative conception rates do not have a bimodal distribution like the ones seen with perinatal survival.

Key Words: Daughter Pregnancy Rate, Fertility, Dairy Bulls

M9 Genetic variation in residual energy intake and its association with body weight, milk yield, fat corrected milk yield and economic merit in dairy cattle. P. Zamani^{*1}, S. R. Miraei Ashtiani¹, A. Naserian², M. Moradi Shahrbabak¹, and A. Nik-Khah¹, ¹Department of Animal Science, Faculty of Agriculture, University of Tehran, Karaj, Iran, ²Department of Animal Science, Faculty of Agriculture, University of Ferdowsi, Mashhad, Iran.

Residual energy intake is defined as the difference between actual energy intake and that predicted on basis of requirements for maintenance, lactation and body weight change. Residual energy intake is proposed as a measure of feed efficiency, because animal efficiency increases as the proportion of accountable energy intake increases or residual energy intake decreases. Variation in residual energy intake in relation to body weight, milk yield, fat corrected milk yield and economic merit (income over feed cost) was investigated using 2589 monthly records collected from 723 Holstein lactating cows in 3 herds. Energy requirements of each cow were estimated using NRC models. Genetic and phenotypic parameters were estimated using Derivative Free approach of Restricted Maximum Likelihood based on two-trait animal mixed model analyses. The model contained fixed effects of herd-year-season, parity number, stage of lactation (months after parturition) and random effects of animal genetic and permanent environment. Heritability estimation of residual energy intake was 0.17 ± 0.07 . Residual energy intake was negatively correlated to body weight, milk yield, fat corrected milk yield and economic merit, both phenotypically (-0.021 , -0.208 , -0.298 and -0.385 , respectively) and genetically (-0.031 , -0.363 , -0.465 and -0.618 ,

respectively). Fat corrected milk showed the most significant correlations with economic merit both phenotypically (0.635) and genetically (0.928). Because of its high correlations with residual energy intake and economic merit, more selection emphasis could be placed on fat corrected milk, when selecting indirectly for feed efficiency and economic performance.

Key Words: Dairy Cattle, Residual Energy Intake, Fat Corrected Milk

M10 Designer pork studies with small-scale farmers targeting niche markets. T. Barrios^{*1}, C. Talbott¹, T. See², and R. Pfortmiller³, ¹North Carolina Agricultural and Technical State University, Greensboro, ²North Carolina State University, Raleigh, ³National Swine Registry, West Lafayette, IN.

Small-scale producers may be able to secure a place at the pork industry table by producing a different type of pork than the the other white meat. By selecting for pork with higher levels of marbling, darker color and optimum pH levels, hog producers may be able to survive by marketing the other red meat through niche markets. Progeny sired from four different genetic populations of boars (not selected for lean conversion) were used to examine the potential to increase intramuscular fat in pork for niche-market application. Forty gilts were randomly assigned to one of four sire lines and bred artificially or by natural service. Upon detection of pregnancy, gilts were distributed to one of four participating farmers. Two castrates from each litter were identified with sire and sow lines and monitored through harvest. Carcass quality was assessed and IMF levels correlated with the presence or absence of the heart fatty acid binding protein (H-FABP) allele. Potential for conducting genetic studies with small-scale farmers are discussed.

Key Words: Designer Pork, Farmer Participatory Research, Niche Markets

M11 Contribution of inbreeding and recessive defects to early embryo loss. P. M. VanRaden and R. H. Miller^{*}, Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.

Lethal recessive genes that cause early embryo loss are difficult to detect because they may appear to be failed inseminations or missed heats. Nonreturn rate at 70 d after first insemination (NR70) was evaluated as a trait of the embryo from 1,739,055 first services using a nonadditive genetic model. Effects modeled included herd-year-season, parity of cow, sire of cow, service bull, interaction of service bull with sire of cow, and regression on inbreeding of embryo. Simultaneous solutions for all effects were not possible; thus, main effect variances were estimated using REML, and those effects were removed from the data. Interaction variance was estimated from the residuals using the tilde-hat approximation to REML. Service bull effects were assumed to be constant across time and unrelated. An additive relationship matrix was used for sire of cow and a dominance relationship matrix for the interaction term. Data included observations from January 1995 through January 2001 and represented 1,251 Holstein service bulls and sires of cows. For each 1% increase in inbreeding, NR70 declined by an estimated 0.096. A regression of this size could be explained by >20% of animals carrying defects that cause early embryo loss. Of the total variance, service bull contributed 0.36%; sire of cow, 0.24% (heritability of 1.0%); and interaction, 0.18% (dominance variance of 2.8%). Number of records per interaction averaged only 6 but with a maximum of 2,077, and 50 bull pairs had >500 records, which resulted in reliabilities of >50% for their interactions. Predicted interactions that included effects of inbreeding ranged from 3.6 to +2.9 as compared to the mean NR70 of 56%. The poorest interactions were not caused by known recessive defects. Complex vertebral malformation (CVM) generally causes loss of pregnancies later in gestation, and few current bulls carry the gene for deficiency of uridine monophosphate synthase (DUMPS). Further study of the families with poorest interactions could uncover new recessive defects.

Key Words: Fertility, Embryo Loss, Recessive Defects

M12 Relationships among measures of growth performance and plasma urea nitrogen (PUN) in barrows. J. Klindt*, USDA-ARS; U.S. Meat Animal Research Center, Clay Center, NE.

Our previous work [J. Anim. Sci. 81(Suppl. 2):36, 2003] showed that plasma concentrations of PUN are genetically regulated and moderately heritable, 0.35. Objective of the present study was to examine the relationships among measures of growth and PUN in grower/finisher pigs. Barrows, $n=96$, $BW=29.3\pm 0.5$ kg, 3 to 4 per litter, 27 litters, were assigned at 69 ± 0.5 d of age. Pigs were placed in individual pens and fed standard grower/finisher diets until slaughter at 118 kg BW. At slaughter, chilled carcass wt (ClDwt) and wt of trimmed lean cuts (Tlncut) were recorded. At 2-wk intervals during the trial BW, average of ultrasonic backfat at three sites, and feed consumption were recorded. At each weighing a blood sample was collected for determination of plasma urea nitrogen (PUN). Within pig PUN was averaged to obtain mPUN. Two pigs were removed before the end of the trial. Data recorded at the end of the trial was adjusted to average slaughter wt, 117.2 ± 0.3 kg. Daily change in average of three backfat measures (ADCBF), ADG, days to slaughter (Tday), final average backfat thickness (FnBF), ClDwt, Tlncut, and mPUN were affected ($P<0.05$) by litter. Litter affected ($P<0.08$) total feed consumed (Tfeed). Feed/d and efficiency of BW gain (Eff) were not affected by litter ($P=0.14$). For the subsequent examination of the relationship of mPUN with growth measures, pigs were classified as loPUN ($n=31$; mPUN, 26.1 to 36.1, mean= 32.1 mg/dL), medPUN ($n=32$; mPUN, 36.4 to 42.1, mean= 39.2 mg/dL), and hiPUN ($n=31$; mPUN, 42.4 to 91.3, mean= 54.3 mg/dL). PUN group influenced ($P<0.05$) feed/d, ADCBF, FnBF, and Tlncut. hiPun barrows had higher feed/d, ADCBF, and FnBF and reduced Tlncut. Effect of PUN group on feed/d, was nonlinear. Results concur with the reported low phenotypic and genetic correlations among PUN and growth measures [Klindt, et al., J. Anim. Sci. 81(Suppl. 2):36, 2003]. These results suggest that selection against PUN may be accomplished without significant sacrifices in growth performance.

Key Words: Plasma urea concentrations, Growth, Genetic influences

M13 Relationship between performance test traits and subsequent reproductive performance of Yorkshire females. Z. B. Johnson*¹ and R. A. Nugent, III², ¹University of Arkansas, Fayetteville, ²The Pork Group, Tyson Foods, Inc., Springdale, AR.

The objective of this study was to examine relationships between performance test traits and subsequent reproductive performance of Yorkshire females. Performance test records were collected in a commercial swine operation from 1992 to 1999. All females in the breed were grown to 100 d of age (AGE100; $n = 38,979$). At this time pigs were weighed (WT100) and selected for performance testing based on a combination of maternal and performance indexes with more emphasis given to the maternal index. Pigs were weighed at the end of the 77-d performance test (WT177; $n = 32,623$) and ADG calculated. Backfat (BF), loin eye area (LEA), and body length (LEN) were measured. Reproductive traits were number born live (NBA; $n = 3,140$ litters) and weaning weight (WWL; $n = 2,892$ litters) of the first litter. Genetic parameters were estimated using an animal model with litter effects and multiple-trait DFREML procedures. A series of two-trait models was conducted to estimate genetic correlations. Fixed effects for performance traits included contemporary group and either age at 100 d or age at 177 d as a covariate. Contemporary group was the only fixed effect for NBA; while age at weaning was included as a covariate for WWL. Estimates of heritability for NBA, WWL, WT100, WT177, ADG, BF, LEA, and LEN were $0.09 \pm .03$, $0.10 \pm .03$, $0.22 \pm .01$, $0.32 \pm .02$, $0.28 \pm .02$, $0.47 \pm .02$, $0.31 \pm .02$, and $0.23 \pm .02$, respectively. Genetic correlations for NBA with WT100, WT177, ADG, BF, LEA, and LEN were -0.43, -0.20, 0.06, 0.01, -0.17, and -0.11, respectively. Genetic correlations for WWL with WT100, WT177, ADG, BF, LEA, and LEN were 0.55, 0.14, -0.04, -0.05, -0.05, and 0.13, respectively. These correlations indicated that 100-d weight of the mother was more related to NBA and WWL than any performance trait measured. Females that weighed more at 100 d of age had smaller litter sizes, but greater weaning weight of the litter.

Key Words: Swine, Performance Traits, Reproductive Traits

M14 Evaluation of the effects of heterosis on reproductive efficiency and milk yield in South Florida. S. I. Madrid*, T. A. Olson, A. de Vries, C. A. Risco, and P. J. Hansen, University of Florida, Gainesville.

Holstein (H), Brown Swiss (B) and Guernsey (G) cows and their crosses were evaluated in South Florida. Levels of heterosis were determined for 305d ME milk production and days open. The herd was located in Okechobee County, Florida. The cows in this herd were grazed for the majority of the day along with supplemental feeding of concentrates. Records provided by Dairy Record Management Systems (DRMS) were utilized in the analyses. This herd had been utilizing crossbreeding for a period of at least 18 years. During the initial years the herd was composed primarily of Holstein and Guernsey cows. Brown Swiss sires and dams were later added to the herd. Breed composition for the animals in the project were determined by using pedigree records kept in DRMS files. Milk yield was analyzed using a model which included the main effects of year, month of calving, lactation number and breed composition. Heterosis levels for milk yield were 11, -1.4, 2.8, 5, -.05, -.004% for H X G, G X H, B X H, H X B, B X G and G X B respectively. Breed of sire is represented first in the cross. Only the heterosis level observed for the Holstein-sired cows from Guernsey dams was significant ($P < 0.05$). The lowest levels of heterosis for milk yield were found for crosses between the Guernsey and Brown Swiss breeds. Days open were calculated using only the last two calving dates of each cow (DYSOPCD). The data were edited to remove records for days open of less than 70 d, the voluntary waiting period practiced in this herd. The model used in the analyses of days open included effects of year, breed composition and lactation number. The days open for purebred H, B and G cows which were 165, 146, and 164 respectively. Days open for H X G, G X H, B X H, H X B, B X G and G X B were 154, 173, 143, 139, 131, and 179d, respectively. The average days open for all crossbred cows was 20 days shorter than that of the average of the purebred cows. The mean heterosis for days open was 10.5% ($P < 0.05$). Thus, these data indicate that while the effect of heterosis on milk yield was small the advantage for reproductive traits might be substantial.

Key Words: Crossbreeding, Dairy Cattle, Florida

M15 Analysis of sow longevity in commercial herds using competing risks. B. R. Southey*¹, S. L. Rodriguez-Zas¹, R. V. Knox¹, J. F. Connor², J. F. Lowe², and B. J. Roskamp², ¹University of Illinois, Urbana, ²Carthage Veterinary Services Ltd., Carthage, IL.

The length of time a sow remains in a herd or sow longevity is an important component of pork production. Removal of a sow from a herd can be due to many reasons including fertility failure, poor reproduction and litter performance, disease, injury, or death. Competing risks analysis of sow longevity provides a suitable approach to account for the different reasons of removal while accounting for the positive, non-normal and censored sow longevity data. Sow longevity records for 158,940 sows from 32 US commercial herds across five years were analyzed under independent competing risks. The reasons for removal were grouped into common categories including fertility, reproduction, litter performance, disease, injury, old age and death. The Cox proportional hazard model was used to analyze sow longevity including effects of genetic line, herd and year of entry. Genetic line included eight major genetic lines that were present in multiple herds. The relative hazard of removal between the major genetic lines varied depending on removal reason. No difference in hazard of removal was observed for fertility category. For the other removal categories the relative hazard of removal varied among the major genetic lines. For example, the hazard ratio for sow longevity between the Camborough 22 and Camborough 15 lines ranged from 0.43 for old age category to 1.3 for longevity related to poor reproduction. This indicated that Camborough 22 sows had a 60% lower hazard of removal due to old age and a 30% higher hazard of removal due to reproductive reasons than Camborough 15 sows. In contrast, under a single removal cause, the hazard ratio of Camborough 22 relative to Camborough 15 line for sow longevity was 0.87 indicating that Camborough 22 sows had a 13% lower hazard of removal than the Camborough 15 sows. These results illustrate the importance of accounting for removal reason in the analysis of sow longevity. The use of competing risks permits the elucidation of the decision process involved in sow removal and identification of opportunities for management intervention to maximize sow longevity.

Key Words: Longevity, Survival Analysis, Swine

M16 Estimation of correlation between maternal permanent environmental effects of related dams in beef cattle. H. Iwasaki¹, S. Tsuruta^{*2}, I. Misztal², and J. K. Bertrand², ¹Niigata University, Niigata, Japan, ²University of Georgia, Athens.

Correlation (λ) between maternal permanent environmental (MPE) effects of dams and their daughters was estimated using a maternal animal model for beef cattle. Two data sets for weaning weight consisted of 82,138 and 88,639 records of Gelbvieh (GV) and Limousin (LM) breeds, respectively. Numbers of dams and animals in the pedigree file were 39,678 and 121,390 for GV and 52,012 and 155,101 for LM, respectively. The model included fixed effects of contemporary group, sex of calf, age of dam at calving and month of calving; fixed regressions on age of calf; random direct genetic, maternal genetic, MPE and residual effects. The REML procedure was employed with a grid search, in which the likelihood was computed for a series of values for λ . Two models Model 1 without λ and Model 2 including λ were compared by a likelihood ratio test. Model 2 fitted the data significantly better than Model 1. The maximum restricted likelihood was obtained for λ of approximately 0.2 for both breeds. Estimates of residual and direct genetic variances were similar for both models. Compared with those of Model 1, estimates of maternal genetic and MPE variances of Model 2 increased and decreased slightly, respectively, for both breeds. Accordingly, the estimates of maternal heritability and the proportion of MPE variance to total variance for Model 2 were higher and lower, respectively, than those for Model 1. For Model 1, estimates of direct-maternal genetic correlation were 0.26 and 0.59 for GV and LM, respectively, while those for Model 2 were slightly lower (0.20 and 0.54). Pearson and rank correlations for direct and maternal effects were very high (>0.99) for both models. These results indicate that the relationship between MPE effects of two subsequent generations for weaning weight in both breeds is negative but low, and that the consideration of maternal environmental relationships between dams and their daughters in the models does not significantly affect the estimates of (co)variance components and may not be important in genetic evaluations.

Key Words: Maternal Permanent Environmental Correlation, AI-REML, Beef cattle

M17 Effects of climate and photoperiod on feed intake of beef bulls during feedlot performance tests. G. T. Tabler, Jr.^{*}, A. H. Brown, Jr., Z. B. Johnson, E. E. Gbur, Jr., I. L. Berry, D. W. Kellogg, and K. C. Thompson, *University of Arkansas, Fayetteville.*

Climate and photoperiod data were analyzed to identify and quantify impacts on feed intake of beef bulls during 52 post-weaning feedlot performance tests. Feed intake data originated from bulls ($n = 1,874$) in University of Arkansas Cooperative Bull Tests at Fayetteville, Hope and Monticello from 1978 to 1990. Bulls were given a 21-d adjustment period, then individually full-fed a total mixed ration twice daily in the same stall for 140 d. As formulated, the diet contained 1.6 Mcal NE_m, 0.9 Mcal NE_g and 12% CP per kg DM. Initial age and weight were recorded at start of each test with weights taken at 28-d intervals thereafter. Photoperiod and climate data were obtained from the U.S. Naval Observatory (Washington, DC) and National Climatic Data Center (Asheville, NC), respectively. Variables included maximum, minimum, average, and dew point temperatures; relative humidity; barometric pressure; rainfall; day length and wind speed. Data were pooled, divided into five 28-d periods, with each period analyzed separately using all animals over all tests. Initial age and initial weight were included in principal components regression as independent variables to adjust for initial animal differences. Principal component analysis was utilized to reduce the number of independent variables in the regression and overcome collinearity concerns associated with photoperiod and numerous climatic variables. Three principal components within each period accounted for 59% to 66% of the variability in explanatory variables. Nine to 14 components accounted for 97% to 100% of variability. Results provide additional information on effects climate and photoperiod have on cattle feeding and indicate photoperiod and climate conditions have differing effects on feed intake of feedlot cattle as feeding periods progress.

Key Words: Beef Cattle, Climate, Feed Intake

M18 Feed efficiency in the West Virginia Bull Test Evaluation Program. E. E. D. Felton^{*}, J. E. Warren, Jr., W. R. Wagner, and J. W. Yates, *West Virginia University, Morgantown.*

The "GrowSafe 4000E" system was installed and used to measure individual feed intake during the 2003-2004 West Virginia Bull Test Evaluation Program. This system of hardware and software consists of feed troughs mounted on load cells. An antenna grid is incorporated in the trough, and animals are fitted with electronic ear tags that are read by the antenna grid. An animal feeding at a trough is identified at five second intervals and feed available in each trough is weighed every second with an accuracy within 50g. The animal identification and feed consumed data are sent wireless via a communication panel to a computer with software to compile individual feed intake and individual feeding events. Bulls arrived at the test station in mid-October, 2003. Following a 3-week acclimation period, bulls were weighed on d 1 and 2: (averaged for on test BW; **IBW**), 42, 77, and 104 and 105 (averaged for off test BW; **FBW**). During the acclimation period and the 105-day test, bulls were fed *ad-libitum* a total-mixed-ration containing 13.6% crude protein and 73.6 and 45.0 Mcals of NEm and NEg per cwt, respectively. A subset of 98 Angus bulls (372 ± 22 days of age, $IBW = 375 \pm 45$ kg, $FBW = 582 \pm 48$ kg) was subjected to correlation analysis of feed:gain data from the beginning of the test to d 42 to various production and descriptive variables. Additional data will be included upon completion of test summary. Weak r-values existed ($P = 0.02$) with frame score (-0.23) and age of the bull (0.24) while much stronger r values existed ($P < 0.001$) with ADG over the entire test period (-0.62) and DMI expressed as a percentage of BW (0.43). There were no detected relationships with birth weight, age of dam, muscle score or longissimus muscle area, back fat and marbling scores measured by ultrasound at the end of the 105 d test period. Many of these variables are important to beef production and are currently used in the selection of sires and dams. These data indicate that it may be possible to also use feed efficiency as an additional selection tool without influencing other important selection variables.

Key Words: Feed Efficiency, Bulls, Beef

M19 Maternal and reproductive performance of crossbred cows mated to moderate or high weaning weight EPD sires. S. M. DeRouen^{*1} and F. A. Thrift², ¹Louisiana State University Agricultural Center, Homer, ²University of Kentucky, Lexington.

Maternal and reproductive performances were evaluated over 5 yr for Angus-, Brahman-, Brangus-, Gelbvieh-, and Gelbray-sired cows when mated to Simmental sires varying in weaning weight (WWT) EPD. Four moderate (MOD) (mean = 9.91 kg WWT EPD) and three high (HIGH) (mean = 17.98 kg WWT EPD) sires were mated to 307 cows by artificial insemination (AI). Accuracies of WWT EPD were > 0.80 . Cows were exposed to clean-up bulls for 60 d following AI. Statistical analyses were conducted using a generalized linear mixed model. Sire type x calf sex interaction was not significant for any response traits studied. A total of 120 AI-sired calves were evaluated. Least squares means for Julian birth date and birth weight for calves sired by MOD and HIGH growth sires were 47.7 d and 41.7 kg and 49.7 d and 44.4 kg, respectively, and did not differ ($P > 0.07$). Weaning weight and 205 d weight for calves sired by MOD and HIGH growth sires differed ($P < 0.04$) and were 271 kg and 248 kg and 284 kg and 261 kg, respectively. A total of 109 cows were evaluated for pregnancy rate while nursing MOD and HIGH growth calves, BW and BCS at weaning, BW and BCS at subsequent breeding, and subsequent pregnancy rate. Pregnancy rates were similar ($P > 0.90$) among cows nursing MOD and HIGH growth calves and were 96.0% and 96.5%, respectively. Body weight and BCS at weaning were 596 kg and 5.47 and 580 kg and 5.39 for cows nursing MOD and HIGH growth calves, respectively, and did not differ ($P > 0.33$). Subsequent BW and BCS at breeding were 600 kg and 5.52 and 579 kg and 5.35 for cows nursing MOD and HIGH growth calves, respectively, and did not differ ($P > 0.19$). Subsequent pregnancy rates were similar ($P > 0.70$) among cows nursing MOD and HIGH growth calves the previous year and were 91.7% and 93.6%, respectively. In conclusion, calf weaning weight differences were similar to sire weaning weight EPD differences and subsequent reproduction was not adversely affected for cows nursing high growth calves.

Key Words: EPD, Reproduction, Weaning Weight

M20 Selection for meat tenderness in Angus. L Praharani*, T. A. Olson, D. D. Johnson, R. L. West, and J. R. Alday, *University of Florida, Gainesville.*

The objective of this study was to evaluate the response to selection of Angus bulls for tenderness based on Warner-Bratzler Shear (WBS) values. The study began with Angus calves born in 1994. About 30-35 bulls were evaluated annually from those born from 1994 through 2000. After evaluation, three or four of the bulls with the highest and lowest WBS values were selected for use. Beginning in 1996, calves were sired by selected bulls. After the bull calves were expected to have reached puberty, at 13 and 14 months of age, semen was collected and frozen. The bulls were then slaughtered and their tenderness was determined using WBS evaluation. The semen from selected bulls was used to inseminate purebred and grade Angus cows at the Santa Fe Beef Unit Angus herd. Warner-Bratzler shear force data from a total of 262 bulls from 45 sires and 195 dams were collected. Analyses were performed to estimate variance and covariance components using AsREML. Genetic trends were plotted as averages of breeding values, estimated by the solution of animal model equations for year of birth, and overall trend was estimated as a regression of all breeding values on year of birth of calves. The average breeding value of progeny of sires selected for tenderness (-0.29 kg) was lower ($P < 0.05$) than that of sires selected for toughness (0.44 kg) over the years of the study. The estimate of direct heritability ($h^2 = 0.41 \pm 0.19$) was quite high. This estimate indicates that selection for meat tenderness in this manner might be effective. The genetic trends for WBS values tended to decrease over the years -0.0038 and -0.0149 kg per year for the progeny of tough and tender selected-sired, respectively. The breeding values of the progeny of both tender and tough selected sires declined. An explanation for declining breeding values of progeny of sires selected as tough is not clear but might be due to the low selection pressure applied in this study, since there were limited numbers of the bulls evaluated and it was not possible to collect freezable semen from all of the bulls prior to slaughter.

Key Words: Selection, Tenderness, Angus

M21 Genetic parameters estimated with multi-trait and linear spline random regression models using Gelbvieh early growth data. H. Iwaisaki¹, S. Tsuruta^{*2}, I. Misztal², and J. K. Bertrand², ¹Niigata University, Niigata, Japan, ²University of Georgia, Athens.

Estimates of direct and maternal genetic parameters in beef cattle were obtained by a random regression model with a linear spline function (SFM) and compared with those obtained by a multi-trait model (MTM). Most of SFM parameters are on the same scale as in MTM, simplifying validation and implementation. Weight data of 18,900 Gelbvieh calves were used, of which 100, 75 and 17% had birth (BW), weaning (WW) and yearling (YW) weights, respectively. The MTM analysis was conducted with a three-trait maternal animal model. The model included an overall linear partial fixed regression on age at recording for WW and YW, and direct-maternal genetic and maternal permanent environmental effects. The SFM included the same effects as MTM, plus direct permanent environmental effect, and heterogeneous residual variance. Three knots, or breakpoints, were set to 1, 205 and 365 d. (Co)variance components in both models were estimated with a Bayesian implementation via Gibbs sampling using flat priors. For BW with no variability of age at recording, a good agreement was observed between corresponding components of variances estimated from both models. For WW and YW, with the exception of the sum of direct permanent environmental and residual variances, there was a general tendency for SFM estimates of variances to be lower than MTM estimates. Direct and maternal heritabilities estimated with SFM tended to be lower than those estimated with MTM, some of which were particularly high. For example, the direct heritability for YW was 0.59 with MTM and 0.48 with SFM. Estimated negative genetic correlation for direct and maternal effects with SFM were lower than those with MTM. For example, the direct-maternal correlation for WW was -0.43 with MTM and -0.33 with SFM. Estimates by SFM may be superior to MTM due to accounting for constant days and also for random effects. The SFM is simpler to implement than a random regression model with Legendre polynomials.

Key Words: Random Regression, Linear Spline Function, Beef Cattle

M22 Estimated genetic parameters for growth, carcass, and tenderness traits of Brahman steers. D. E. Franke^{*1}, T. Smith¹, J. D. Domingue¹, T. D. Bidner¹, and J. C. Paschal², ¹LSU Agricultural Center, Baton Rouge, LA, ²Texas A&M University, Corpus Christi, ³University of Nebraska, Lincoln.

Purebred Brahman bull calves ($n=430$) were purchased at weaning from private breeders in Louisiana (1996 through 2000) to evaluate genetic (co)variation for growth, carcass, and tenderness traits. Calves were castrated, vaccinated, dehorned, dewormed, and backgrounded and grazed on ryegrass for an average of 120 d over the 5 yr period. Steers were fed in south Texas. Steers were harvested in groups of 20 to 30 head when the group reached 500 to 575 kg BW and 7 to 10 mm fat thickness. Carcasses were electrically stimulated and chilled for 24 hr. A 15-g 24 hr postmortem longissimus muscle sample was taken for calpastatin assay. A primal rib was purchased and 2.54-cm-thick steaks were cut for 14-d aging. Tenderness was determined by averaging the force required to shear six 1.26 cm cores taken parallel to muscle fibers. A full animal model was used to estimate genetic (co)variation in order to compute heritability and genetic correlations. Heritability estimates (\pm SE) were .33 (.14) for feedlot adg, .56 (.15) for hot carcass weight, .51 (.16) for ribeye area, .38 (.17) for fat thickness, .49 (.17) for yield grade, .38 (.16) for marbling score, .21 (.11) for shear force, and .44 (.17) for calpastatin activity. Most genetic correlations were below .25 with similar magnitude of standard errors. Exceptions were -.63 (.25) for yield grade and shear force and -.43 (.17) for marbling score and calpastatin activity. These genetic parameters indicate possible response from selection.

Key Words: Brahman Steers, Carcass Traits, Genetic Parameters

M23 The use of real time ultrasound to estimate variance components for growth and carcass traits in Nelore cattle. C. U. Magnabosco^{*1,2}, F. R. C. Araujo^{1,3}, F. Manicardi⁴, J. R. Hofig Ramos⁵, C. U. Faria², R. B. Lôbo⁶, L. A. F. Bezerra⁶, T. R. Famula¹, and R. D. Sainz¹, ¹University of California, Davis, ²Embrapa Cerrados, Bolsista CNPq, ³Aval Serviços Tecnológicos S/S, ⁴Grupo OMB, ⁵Grupo HoRa, ⁶Universidade de São Paulo.

Real-time ultrasound (RTU) technology was used for collection of data on carcass traits thg Nelore cattle in Brazil, for longissimus muscle area (ULMA), backfat between the 12th and 13th ribs (UFAT), and rump fat at the P8 site (URFAT). The data were collected on ranches in southeastern and midwestern Brazil (Grupo OMB and Grupo HoRa, participants of the Program for Genetic Improvement of the Nelore Breed - PMGRN). The final data set contained 1,721 animals at approximately 15, 18, 21 and 24 months of age, that were produced by 85 different sires. These data were analyzed to estimate genetic parameters and calculate Expected Progeny Differences (EPDs). The pedigree file used for calculation of the inverse numerator relationship matrix contained 25,941 animals, including those augmented so that each animal with data had two ancestral generations. The linear model included fixed effects for contemporary groups (herd-year-season-sex) and age of dam at calving. The model also included random effects for direct genetic effects. Data were analyzed using both a single and bivariate animal model. A Multiple Trait Derivative Free Restricted Maximum Likelihood (MTD-FREML) was used to establish the variance components and genetic parameters. Heritability estimates for ULMA, UFAT and URFAT were 0.29, 0.44, and 0.62, respectively. The EPDs for all traits presented a range that allows the possibility to significantly improve carcass quality in Nelore cattle. Ultrasound scan data produced consistent and heritable results for Nelore cattle and they may be used in genetic evaluation schemes to improve carcass traits.

Key Words: Beef Cattle, Carcass Traits, Genetic Evaluation

M24 Assessment of temperament at weaning in calves produced from diallel matings of Angus, Brahman, and Romosinuano. D. G. Riley^{*1}, C. C. Chase, Jr.¹, S. W. Coleman¹, R. D. Randel², and T. A. Olson³, ¹USDA, ARS, Brooksville, FL, ²TAES, Overton, ³University of Florida, Gainesville.

Objectives were to assess breed differences and estimate genetic effects for measures of temperament in cattle: exit velocity (m/s; higher values may indicate more excitable temperament) of calves when released from a squeeze chute; chute score and pen temperament score, the subjective evaluations of calf behavior when confined in a chute or approached in

an open pen. Scores were rated from 1 to 5; higher scores indicated more nervous or aggressive behavior. Calves (n = 657) were from diallel matings of Angus (A), Brahman (B), and Romosinuano (R; tropically adapted Colombian breed). Fixed effects included breed (n = 9), calf sex, year (n = 2), farm (n = 3), day of record (n = 3; 0, 24, or 72 h post-weaning). Order through the chute and calf age at weaning were covariates. Random effects were calf and sire. BB (sire and dam breed, respectively) calves had the highest values for exit velocity, chute score, and pen score (2.41 ± 0.1 m/s, 2.42 ± 0.06 , 3.31 ± 0.09); all were higher ($P < 0.05$) than all other breed groups for chute and pen score, and had higher ($P < 0.05$) exit velocity than all but BA and AB. RR calves had the lowest exit velocity (1.66 ± 0.07 m/s), lower ($P < 0.05$) than all but AA, RA, and AR. AA calves had the lowest values for chute and pen score, lower ($P < 0.05$) chute score than all but RR, and lower ($P < 0.05$) pen score than all but RR and RA. Estimates of direct breed effects for exit velocity ($P < 0.001$) were 0.68 ± 0.16 m/s for B and 0.49 ± 0.14 m/s for Romosinuano. Estimates of direct effects for chute and pen score were highly significant for B (0.91 ± 0.1 and 1.13 ± 0.15), A (0.5 ± 0.1 , 0.6 ± 0.14), and R (0.41 ± 0.09 , 0.52 ± 0.13). Estimates of heterosis ($P < 0.05$) were 0.21 ± 0.09 m/s (7.4%) for exit velocity for B with A, 0.12 ± 0.05 (3.1%) for chute score for A with R, and 0.18 ± 0.08 (3.2%) for pen score for R with B. Results suggest that R may be included in similar breeding programs without detrimental temperament changes.

Key Words: Brahman, Romosinuano, Temperament

M25 Estimates of adaptability and stayability for postweaning weight gain in crossbred beef cattle raised in five environments in Brazil. J. C. d. C. Balieiro^{*1,2}, J. B. G. Barros², J. B. S. Ferraz¹, J. P. Eler¹, E. d. S. Balieiro^{*3}, L. G. G. Figueiredo¹, and E. C. Mattos¹, ¹University of São Paulo, Duqu de Caxias Norte, 225. Pirassununga/SP-Brazil, ²University Center of Av. Dr. Octavio da Silva Bastos, S/n. S. João da Boa Vista/SP-Brasil, ³Federal Rural University of Rio de Janeiro, Rodovia BR-465, km 47. Serpédica/RJ-Brasil.

This study was conducted to evaluate adaptability and stability parameters of nine genetic compositions of crossbred European-Zebu cattle raised in five different Brazilian environments. Data (n=16,546) from the present study refer to characteristic gain from weaning up to 160 days postweaning. The statistical model included the effects of genetic composition (G), environment (E), GxE interaction and contemporary group within E. Also included was a covariate adjustment for cow's age at calving (linear and quadratic). All sources of variation in the analysis were highly significant ($P < 0.01$). The decomposition of the GxE interaction was accomplished by regression method. Intercepts ($\beta_{0(i)}$) for genotypes 2, 3 and 5 showed the highest weight gains up to 160 days postweaning. On the other hand, the genotypes 7, 9, 8 and 6 showed the smallest postweaning gains. Based on t-tests for the angular coefficients ($\beta_{1(i)}$) adjusted for the environmental index from each environment, it was verified that only genotype 2 had general adaptability. In contrast, genotypes 1, 3, 4 and 5 were classified as having specific adaptability to favorable environments and genotypes 6, 7, 8 and 9 were classified as having specific adaptability for unfavorable environments. The variance components related to the deviations of the regression for the genotypes indicated that all genotypes had low stability. Genotypes 3 and 5 should not be considered completely undesirable since they had high weight gains and coefficients of determination from the regression. The adaptability analysis was efficient in discriminating among genetic types. However, the stability analysis was not effective in discriminating the variance components attributed to deviations from regression. In this case, it was necessary to use another approach (coefficient of determination) to aid in decision making.

Key Words: Adaptability, Crossbred Cattle, Beef Cattle

PSA-Genetics

M26 Interaction genotype and protein level on feed efficiency of Japanese quail in dry tropic weather. J. J. Portillo^{*1}, R. Barajas¹, M. A. Carmona², F. G. Rios¹, and G. Contreras¹, ¹FMVZ - Universidad Autónoma de Sinaloa (Mexico) Carr. Culiacan-Mazatlan km 3.5, ²FES Cuautitlan UNAM (Mexico) Cuautitlan Izcalli, Estado de México.

This study was conducted to evaluate the interaction genotype and protein level and protein level on egg production of Japanese quail, were used 515 females and 200 males of four strains: 1) HH, quails selected for high mature weight; 2) LL, quails selected for low mature weight; 3) HL, reciprocal crosses from males HH with females LL; and 4) LH, reciprocal crosses from males LL with females HH. At 52 days old, the quails was contained in batteries with five levels and four cage by level. In each cage, was allocated six females and two males. With base at arrangement combinatory, five cages of each strain was designated a 16, 19, 21, 24, and 27 % of crude protein (CP) level. During eight weeks, was registered egg production and egg weight from strain and protein level. Each week was measurement the feed intake (FI) only by three days consecutives. To evaluate the interaction genotype-protein level, was utilized a general lineal model of fixed effects by week, strain, protein, and interaction strain-protein level, the tendency on the response was determinate by orthogonal polynomials, a simple lineal regression was used to estimate protein level with better feed efficiency (FE). ANOVA shown effect ($P < 0.01$) in FE by week production, strain, protein level, than as interaction by week x strain, and strain x protein, the tendency by FE was lineal ($P < 0.01$) to strain HH, and quadratic ($P < 0.03$) to strain HL, LH and LL, with CP levels and FE estimated of 26, 20.5, 16, 16 %, and 0.246, 0.248, 0.219, 0.264, to strain HH, HL, LH and LL, respectively. It is concluded, that exist interaction genotype protein in FE to egg production in Japanese quail, and better FE in low mature

weight strain with 16 % CP, than high mature weight strain require 26 % CP.

Key Words: Protein Level, Feed Efficiency, Coturnix coturnix japonica

M27 Interaction genotype - protein level on egg quality of Japanese quail in dry tropic weather. J. J. Portillo^{*1}, R. Barajas¹, M. A. Carmona², F. G. Rios¹, G. Contreras¹, and I. V. Ferrer¹, ¹FMVZ - Universidad Autónoma de Sinaloa (Mexico) Carr. Culiacán-Masatlan km 3.5, ²FES Cuautitlan - UNAM (Mexico) Cuautitlan Izcalli, Estado de México.

To evaluate the interaction genotype and protein level on egg quality of Japanese quail, were used 639 eggs from four strain: 1) HH, quails selected for high mature weight; 2) LL, quails selected for low mature weight; 3) HL, reciprocal crosses from males HH with females LL; and 4) LH, reciprocal crosses from males LL with females HH. At 52 d old, the quails was contained in batteries with five leves and four cage by level. In each cage was allocated six females and two males. With base at arrangement combinatory, five cages of each strain was designated a 16, 19, 21, 24, and 27 % of crude protein (CP) level. From two weeks start hatching and every 14 d, during egg was collected by strain - CP level combination. The next measurement weight, length, width of eggs, dense albumin height, yolk height, and width. From these data, shape index (SI), yolk index (YI), and Haugh Units (HU) were calculated. To evaluate the interaction genotype-protein level, was utilized a general lineal model of fixed effect by week, strain, protein, and interaction strain-protein level, the tendency of the response determinate by polinomial and the means comparison was used contrasts. ANOVA shown effect ($P < 0.03$) in SI, YI, and HU, by week, strain, protein level, and strain x protein level, except to genotype-protein interaction in HU ($P = 0.20$). Was observed lineal response ($P < 0.01$) and difference between 16-19-21 vs. 24-27 % of CP ($P < 0.01$) in SI to strain HH with

79.12 vs. 77.96; strain LH, the lineal tendency ($P < 0.01$) was by difference between 16-19 vs. 21-24-27 % ($P < 0.01$) with 76.90 vs. 78.35; egg SI of strain HL and LL, was similar between CP level ($P > 0.10$) with 78.16 and 77.36. YI and HU were similar between CP levels ($P > 0.10$) in four strain, with 45.50, 43.37, 44.62, and 43.68 to YI, and 93.16, 92.52, 92.06, and 89.98 to HU in HH, LL, LH, and HL, respectively. It is concluded, than exist interaction genotype-protein level to SI and YI, but not to HU, although CP levels to 16 at 27 % was not affected YI and HU.

Key Words: Protein Level, Egg Quality, Coturnix coturnix japonica

M28 Effect of genotype and protein level on hatchability of Japanese quail in dry tropic weather. J. J. Portillo*¹, R. Barajas¹, M. A. Carmona², F. G. Rios¹, G. Contreras¹, and S. Aza¹, ¹FMVZ - Universidad Autonoma de Sinaloa (Mexico) Carr. Culiacan-Mazatlan km 3.5, ²FES Cuautitlan - UNAM (Mexico) Cuautitlan Izcalli, Estado de Mexico.

To evaluate the interaction genotype and protein level (IGP) on hatchability of Japanese quail in dry tropic weather, were incubated 5176 egg four strains, 1) HH, quails selected for high mature weight; 2) LL, quails selected for low mature weight; 3) HL, reciprocal crosses from males HH with females LL, 4) LH, reciprocal crosses from males LL with females HH. At 52 days old, the quails were contained in batteries with five levels, and four cage by level. In each cage was allocated six females and two males. With a base at arrangement combinatory, five cages of each strain was designated to consume 16, 19, 21 (control), 24 and 27 % PC. After two weeks of adaptation, each 21 days, egg hatch was selected and incubated with four repetitions by treatment. To evaluate the interaction genotype-protein level, was used a general lineal model to fixed effects by period, strain, protein, and interaction genotype-protein level, comparison means by orthogonal polynomials. ANOVA shown effect ($P < 0.01$) of period and protein, but not was strain ($P = 0.60$), and IGP ($P = 0.29$), with 71.35, 68.31, 64.79, 77.13, and 77.81 % for 16, 19, 21, 24 and 27 % respectively, with difference between control vs. others level ($P < 0.01$), the levels of 16-19 vs. 24-27 ($P < 0.01$), without difference between 16 and 19 ($P = 0.40$), and 24 and 27 % PC ($P = 0.86$). It is concluded that not exist interaction genotype-protein level on hatchability of fertile eggs, and 24 % is the better level.

Key Words: Protein level, Hatchability, Coturnix coturnix japonica

M29 Relationship between internal and external egg characteristics of Japanese quail. J. J. Portillo*, G. Contreras, F. G. Rios, and I. V. Ferrer, FMVZ-Universidad Autonoma de Sinaloa, Mexico Carr. Culiacan-Mazatlan km. 3.5.

With the objective of characterize the relationship between measuring internal and external egg of Japanese quail, were measured weight, length, width, height and width of yolk, and dense height of 1644 eggs. From this data were calculated: shape index (SI), yolk index (YI) and Haugh Units (HU). Data was conducted a descriptive analysis and correlation lineal simple (Pearson coefficients). Egg weight (13.89 ± 1.44) was related ($P < 0.01$) mainly with the width (26.93 ± 0.98 mm) with correlation coefficients of 0.82 to 0.90, length (37.01 ± 1.74 mm) 0.70 to 0.78 and width of yolk (25.99 ± 1.66 mm), 0.52 to 0.64. The width of the egg was related ($P < 0.01$) with the length, with coefficients of 0.44 to 0.51, as well as with the weight of yolk, 0.52 to 0.57. Length associates in negative form ($P < 0.01$) with SI (77.93 ± 3.39), -0.70 to -0.72, as well as width of yolk (0.48 to 0.53), and the height of yolk (11.40 ± 1.26 mm) 0.28 to 0.44. YI (44.24 ± 4.46) this determined ($P < 0.01$) for the height of the yolk (0.80 to 0.82) and in minor grade and negative form the width the yolk (0.17 to -0.41), while the measurements of yolk associate with values of 0.20 to 0.40. Haugh Units (91.85 ± 4.72) was determined ($P < 0.01$) for the dense albumin height (5.26 ± 0.90 mm) 0.98 to 0.99, and still when for their calculation the egg weight is employed, it has a null relationship ($P = 0.19$) whit is (0.01 to 0.05). The remainder of the correlations has a minor magnitud to 0.30. It is concluded that the most related positive measurements is weight and the width of the egg, length with the shape index, height of the yolk with the yolk with the yolk index, and the Haugh Units with dense albumin height, with negative relationship of the length of the egg with shape index.

Key Words: Egg Measures, Correlation, Coturnix Coturnix Japonica

M30 Interaction of Breed-by-Chitosan Supplementation on Growth and Feed Efficiency at Different Supplementing Ages in Broiler Chickens. Yoon O. Suk*¹ and Hyung C. Sung², ¹Sahmyook University, 26-21 Kongneung Dong, Nohwon-Ku, Seoul South Korea, ²EZ Life Science Co., Ltd., 335 Yangjae Dong, Seocho-Ku, Seoul, South Korea.

Three experiments were conducted to investigation the interaction of breed-by-chitosan supplementation on the major economic traits in broiler chickens. In experiment 1, one-day-old broiler chicks were fed ad libitum on a basal diet (CON-group) or basal diet containing chitosan at an inclusion level of 10.5 mg/bird/day (EXP-group). In experiments 2 and 3, the diets of 15-day-old broiler chicks were supplemented by the same amount of chitosan as used in experiment 1. In experiment 1, the mean body weight of the EXP-group chickens were significantly ($P < 0.05$) heavier in comparison with those of CON-group birds on day 21 of the experiment in two of three breeds. Furthermore, the EXP-group birds showed to be significantly ($P < 0.05$) heavier than the CON-group birds in all of the three breeds on day 28 and 35 of the experiment. Especially in the 35-day-old mean body weight, the EXP-group birds of Arbor Acres, Peterson, and Ross were significantly ($P < 0.05$) heavier by 121.8 g, 118.5 g, and 242.8 g than the CON-group birds, respectively. However, the body weights in experiments 2 and 3 did not significantly differ between the CON-group birds and the EXP-group birds fed with chitosan supplementation from day 15 post birth. The mean 15 35 d FCR of the EXP-group birds were generally lower ($P < 0.05$) than that of the CON-group birds in experiment 1 only. By the results of the analysis of variance, the breed-by-diet (chitosan) supplementation interactive effect on 35-day-old mean body weight and 1 35 or 15 35 day-old mean weight gains showed significant ($P < 0.05$) in experiment 1 only; however, these traits in both experiment 2 and 3 were not shown significant interaction of breed-by-diet supplementation. The interactive effects of breed-by-diet supplementation on the mean 15 35 d FCR. Results of these experiments indicate that dietary supplementation with chitosan for the improvement of growth or feed conversion ratio has an efficacy when the supplementation begins from one-day-old broiler chickens.

Key Words: Breed, Chitosan, Broiler

M31 Male and female fertility and hatchability in chickens: A longitudinal mixed model approach. R. L. Sapp*¹, R. Rekaya¹, I. Misztal¹, and T. Wing², ¹The University of Georgia, Athens, ²Cobb-Vantress, Inc., Siloam Sprints, AR.

The objective was to investigate different approaches for handling missing records and to develop and implement a multivariate longitudinal mixed model for the genetic evaluation of male and female fertility and hatchability in chickens. Traits recorded on a weekly basis were eggs set (E), fertility percentage (F), and percentage hatched of fertile eggs (H). Three approaches for handling missing records were investigated: 1) records with zero weekly laid eggs were removed and remaining records with missing F and H were predicted (M1); 2) missing records, including zero weekly laid eggs, were assumed known and equal to zero (M2); and 3) zero weekly laid eggs were assumed as a valid record and missing F and H were predicted (M3). A longitudinal mixed model was employed for the multiple trait analysis of E, F, and H. Fixed effects included week-flock, age of service sire, and age of hen; unrelated service sire, additive hen, permanent environment, and residual were included as random effects. Heritability estimates of E, F, and H ranged from 0.104 to 0.127, 0.055 to 0.074, and 0.059 to 0.074, respectively, using the three methods. Heritability estimate of E using M1 was significantly higher than estimates obtained from M2 or M3 suggesting that removing records of E that were zero was not the best approach. Heritability estimates of F and H using M2 were significantly larger than estimates obtained from M1 or M3 indicating that predicting missing F and H was a better approach than assuming missing F and H were zero. Correlations among the three traits were highest using M2 and lowest using M1. Pearson correlations indicate that virtually no reranking of animals or service sires was expected between M2 and M3 for the three traits. However, greater reranking could occur when using M1. Therefore, M1 should not be used for the analysis of longitudinal fertility and hatchability data in chickens. Furthermore, M3 seems to be the most ideal method for handling missing records.

Key Words: Eggs Set, Fertility, Percentage Hatched of Fertile Eggs

M32 Growth parameters of live body weight, feather and protein weight of four commercial laying-type pullet strains. R. Neme¹, N. Sakomura*¹, F. Fialho², E. Carrilho¹, and F. Santos¹, ¹Faculdade de Ciências Agrárias e Veterinárias-Universidade Estadual Paulista Jaboticabal-SP Brazil, ²EMBRAPA Bento Gonçalves - RS.

A study was conducted to evaluate the growth curves of four commercial laying-type pullet lines, from 1 to 18 weeks. 300 birds of each line, Hy line Brown (HLB), Hy line White 36 (HLW), Hisex Brown (HSB), and Hisex White (HSW) were distributed into 4 groups of 75 birds. Eight birds of each group were slaughtered weekly to determine the chemical composition and to measure feathers weight. The data were used to the Gompertz growth equation in order to estimate the growth parameters $W_t = W_m \exp(-\exp(-b(t-t^*)))$. The weights of body, feather, protein and fat contents at time t (W_t) were described in terms of the mature weight (W_m , g), their rates of maturing (b), and the time to reach the maximum rate of growth of each component (t^* , day). According to the growth parameters for live weight, the HLB, HSB and HSW showed lower b than HLW, consequently, those lines showed higher t and W_m than HLW. The brown pullets presented higher feathers weight at maturity (W_m) and b compare to the white pullets. The HLW took more time (58 days) to reach the maximum rate of feathers growth. In contrast to the results of live BW, this strain exhibited the lowest t, indicating that it was precocious to BW. The W_m and t for body protein weight for Hy line were higher than those of Hisex, however the b for Hy line were inferior to Hisex. The b for protein deposition showed that the pullets are near to the maximum development of lean and visceral tissue. The rates of protein deposition at maturity were higher for HLB than HLW and for HSB than HSW, which could modify the protein requirements, and show that the genetic provides differences in body composition.

Growth curve parameters for the pullet strains studied

Parameters	HLB	HLW	HSB	HSW
Live weight				
W_m	2060	1533	2064	1598
b	0.023	0.026	0.023	0.023
t^*	59	52	59	55
Feather weight				
W_m	165	158	157	142
b	0.032	0.026	0.032	0.028
t^*	55	58	56	55
Protein weight				
W_m	782	678	657	509
b	0.022	0.020	0.026	0.024
t^*	71	71	63	60

Key Words: Growth Parameters, Body Composition, Laying-Type Pullet Lineages

M33 A comparison of carcass fat variables in different meat-type breeds of chickens. Z. Niu*, F. Liu, and S. Zhai, College of Animal Science & Technology, Northwest Sci-Tech University of Agriculture & Forestry, Yangling, China.

The genetic characteristics of carcass and the cellularity of the adipose tissue were analyzed and compared when a Chinese local breed (White-feather Lueyang, WL), a modern commercial broiler strain (Arber Acres, AA), and their F1 achieved a common physiological age. The result demonstrated that, compared with AA and F1 broilers at a body weight of 1800 g, WL broilers had lower breast meat yield, higher leg meat yield, and lower abdominal fat weight ($p < 0.05$ or $p < 0.01$), and the slaughtering age of WL was 132 d, which is 3 times more than that of AA (43 d). The number of adipose cells of WL in the abdominal fat pad was significantly greater, but the size of adipose cells was smaller ($p < 0.01$). F1 broilers had a greater positive heterosis in growth rate and abdominal fat deposition. High-protein diet can significantly reduce fat deposition of broilers, and there is a greater interaction between genotypes and diets.

Key Words: Meat Performance, Physiological Age, Meat-Type Chicken

M34 Identification of virulence genes in Salmonella enteritidis required for survival in chicken infection. R. K. Gundelly* and Y. M. Kwon, University of Arkansas, Fayetteville.

Salmonella enteritidis (SE) is one of the most common serotypes of Salmonella causing food borne diseases in industrialized countries, which is frequently associated with chicken shell eggs. Persistent infection of SE in laying hens is an essential step for contamination of forming eggs. We have devised a genetic technique, termed transposon footprinting and demonstrated the utility of the technique in the rapid identification of SE genes that are required for survival during infection of 5-day-old chickens. The transposon-flanking sequences were amplified simultaneously from each pool of 24-30 random SE Tn5 mutants (input pool) and the mutants recovered from the spleen of infected chickens (output pool). Several mutants attenuated during infection were identified by the PCR bands that are present in the input pool but not in the corresponding output pool. We will continue the mutant screening, and the attenuated mutants identified in this screening will be tested for attenuation during infection of adult laying hens. We expect that the results of this study will contribute to the development of effective method to control egg contamination.

Key Words: Salmonella Enteritidis, Transposon Footprinting, Chicken

M35 Specific gene cloning and sequencing in pectoral muscle of Korean native chicken. S. Sun*, N. Kim, S. Kim, and D. Kim, Chonnam National University, 300 Yongbong-dong, Buk-gu, Gwangju, 500-577, Korea.

The objective of this study is to identify specific functional genes that related with growth in Korean native chicken (KNC). The KNC (12 months old, 2.4kg) and Cornish chickens (16 months old, 2.7kg) were obtained from Korean Livestock Research Institute. Pectoralis muscles were dissected and frozen immediately in liquid nitrogen. mRNA was subtracted by suppression hybridization method using PCR-select cDNA Subtraction Kit. Cloned cDNA were inserted in PCR4 Blunt-TOPO vector. The cloned vector was transformed in TOP 10 electro-competent cells. Cloned DNA was sequenced and the homology was compared with GEN-Bank in NCBI. The inserted DNA size was 0.5 - 1.0kb from agarose gel electrophoresis. Seven hundred cDNAs were sequenced and they were identified as triosephosphate isomerase, glyceraldehyde-3-phosphate dehydrogenase, 11-beta-hydroxysteroid dehydrogenase, carbamoyl phosphate synthase, endo-1,4-beta-D-glucanase, and makorin etc. Most genes were not specific in KNC. However, several candidates' genes were identified as a KNC specific DNA. We have been found eight (KNC-NDS-Clone 6, 8, 12, 13, 21, 22, 23, and 24) specific cDNA clones. These sequences were very low (less than 5%) homology in GEN-Bank. Three sequences were registered in GEN-Bank (Chicken, Korean native breast muscle cDNA clone KNC-NDS6, 8, and 21, Bankit 579658, 579768, 584343, respectively). The function was not confirmed yet, but they are related with pectoralis muscle development in chicken.

Key Words: Korean native Chicken, cDNA Clone, Gene Cloning

M36 Chicken and quail microsatellite primers are not efficient markers for guinea fowl. S. N. Nahashon*, N. Adefope, A. Amenyeu, and D. Wright, Institute of Agricultural and Environmental Research, Tennessee State University, Nashville.

Microsatellite markers are tandem repeats of short nucleotides which are abundant, evenly distributed and highly polymorphic in eukaryotic genomes. As such, they are a useful tool in poultry breeding. Microsatellite markers have been identified in genomes of poultry such as chickens and quail. Exchange of marker information between chickens, quail and other avian species such as guinea fowl would be an important step towards the construction of a high-resolution comparative genetic map of these poultry species of agricultural importance. Using the polymerase chain reaction, chicken and quail microsatellite markers were tested to see if they would be suitable as genetic linkage markers in guinea fowl. Eighty three percent (30/36) and 73 percent (19/26) of chicken and quail primers, respectively, amplified individual loci in guinea fowl. Fifty percent (15/30) and 42 percent (8/19) of the amplified loci using chicken and quail primers, respectively, were found to be polymorphic. These very few chicken and quail microsatellite markers that seem to work well in guinea fowl could be used as anchor points for comparative mapping.

However, more effort should be committed to developing guinea fowl-specific markers since those of chickens and quail may not be sufficient for studies in guinea fowl.

Key Words: Guinea Fowl, Microsatellite Markers, Polymorphisms

M37 Withdrawn by author. . .

M38 Dioxin-induced changes in chicken macrophage (HD11) gene expression. N. Puebla-Osorio^{*1}, K. S. Ramos³, D. Abi-Ghanem¹, M. H. Falahatpisheh³, and L. R. Berghman^{1,2}, ¹Department of Poultry Science, Texas A&M University, College Station, ²Department of Veterinary Pathobiology, Texas A&M University, College Station, ³Center for Genetics and Molecular Medicine, University of Louisville Health Sciences Center, Louisville, KY.

In this study, we used specific chicken immune cDNA arrays (constructed at the Fred Hutchinson Cancer Research Center) to identify the transcriptional profile induced by 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in chicken macrophages (HD11). The complete array contained 3,011 chicken lymphocyte cDNA spots representing 2,200 genes. Cultures of the chicken myelomonocytic line HD11, transformed by the myc-encoding MC29 virus, were exposed to two doses of TCDD (1 and 10 nM) for 6 and 12 h. Cells exposed to a similar amount of DMSO were used as the negative controls. Total RNAs were extracted using the Trizol method. The labeled cDNA samples (Cy3 and Cy5) were co-hybridized to an individual array. Scanning and image processing involved a GenePix 4000 scanner. The resulting images were analyzed using GenePix Pro 3.0. The Log₂ values of the median of ratios were used. Upon filtering, a total of 217 genes showed significant up- or down regulation, and were further analyzed using hierarchical clustering (HCL) and tree formation, k-means clustering, and self-organizing maps (SOM). Nine clusters were formed using tree average linkage of genes with similar expression. Seven clusters were selected from the SOMs. K-means clustering produced 6 clusters. At least a 2-fold up-regulation after 6 h of exposure to TCDD (regardless of the dose) and subsequent down-regulation after 12 h of exposure, was observed in the following genes: mitochondrial cytochrome C, M phase inducer phosphatase 2, lysosomal transmembrane protein, alpha enolase, and HSP70

M41 Preparation and characteristics of spent hen meat enzymatic hydrolysate. O. Sangthrapitikul, Y.C. Chen*, and T.C. Chen*, *Mississippi State University, Mississippi State.*

Excessive expansion of egg industry resulted in abundant availability of spent hen. Meat from spent hens is generally tough and poor in functional properties. Due to the inherent qualitative differences between broiler and spent hen meat, the spent hen meat has created a difficulty in its effective disposal.

Spent layer carcasses were obtained from a commercial spent hen processing plant and breast meat was hand-deboned. Bromelain (B), trypsin (T), papain (P), and *Aspergillus oryzae* protease (A) were purchased from Sigma Chemical Co. (St. Louis, MO). Fine ground breast meat, water, and enzyme were mixed and hydrolyzed in a water bath at 50°C for four hours. For optimal hydrolyzing pH selection, the pH of the meat suspension were adjusted by adding either 1N HCl or 1N NaOH. The enzyme activity was terminated by placing the reaction bottles in boiling water for 15 min. Optimal hydrolyzing pH and concentration were determined for each enzyme and enzyme combinations. The sensory characteristics of enzymatic hydrolysates were also investigated.

Data indicated that the optimal pH values for enzyme hydrolysis of spent hen breast meat suspension were: 5.0-7.0 for B, 6.0 for T, 5.0-7.0 for P, and 5.0-7.0 for A. One percent (w/w) of P and A based on raw meat weight showed the highest (P<0.05) hydrolysis efficacy, followed by 0.5% (w/w) and 0.1% (w/w). Considering the enzyme cost factor, the hydrolysates from A, P+A, P+B, and P+A+B were selected for sensory study. Undiluted enzymatic hydrolysates showed higher (P<0.05) scores in chickeny, meaty, mouth feeling, bitterness, and umami sensory

and HSP90. Consistently down-regulated genes included: inflammatory response-related MTMMP2 (matrix metalloproteinase 2), AKT1 (involved in TNF-related activation of NFκB), and oxidative-stress related neuronal NOS, among others. Specific primers will be designed for each of these genes and real-time PCR will be used for validation of the microarray data.

Key Words: Dioxin, Microarray, Macrophages

M39 The expression of genes related to egg production performance in the liver of Taiwanese country chickens. S. T. Ding^{*1}, Y. H. Ko¹, M. C. Huang², Y. P. Lee², and W. T. K. Cheng¹, ¹Dept. of Animal Science, National Taiwan University, Taipei 106, Taiwan, ²Dept. of Animal Science, National Chung Hsiung University, Taichung, Taiwan.

The purpose of this study was to detect expression of genes related to egg production performance in Taiwanese country chickens by suppression subtraction hybridization (SSH). Liver samples from two Taiwanese country chicken breeds (L2 and B lines) with very distinct egg production rates were taken for mRNA extraction. The SSH procedure utilized a kit from Clontech (PCR Select). Two-way subtraction was performed and the differentially expressed gene fragments were cloned into pGEM-T Easy TA cloning vector (Promega). cDNA from the high egg production line (L2) was subtracted by the cDNA from the low egg production chickens (B). The resulted clones were selected for sequence analysis by a genetic analyzer (ABI 3730). We have select 288 clones for forward subtraction and 96 clones for the reverse subtraction. These genes were subjected to further differential screening to confirm the differential expression of genes between the two genetic breeds of chickens. We found that at least eight genes expressed greatly in the liver of L2. Among the genes were chicken apoVLDLII, liver basic fatty acid-binding protein, and two novel genes. We have also found that a glucose-regulated protein and chaperonin T-complex protein 1 were highly related to the poor egg production trait. The chicken apoVLDLII and liver basic fatty acid-binding protein in the liver involved in the egg yolk ingredient deposition. Greater expression of these genes assures more egg forming capacity in order to generate greater egg production rate. Specific functions of the other genes for egg production need to be further investigated.

Key Words: Chicken, SSH, ApoVLDLII

M40 Withdrawn by author. . .

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attributes compared with the controls but there were no (p<0.05) difference on all sensory attributes among those enzyme hydrolysates. Generally, P+A showed the highest acceptability in sensory attributes among treatments followed by P+A+B, A, and P+B. Considering enzyme efficacy, cost, and sensory attributes, P+A and P+A+B were recommended for spent hen meat hydrolysate preparation.

Key Words: Spent Hen Meat, Enzyme, Hydrolysate

M42 Spent hen meat enzymatic hydrolysate as a flavoring base. O. Sangthrapitikul, Y. C. Chen*, and T. C. Chen*, *Mississippi State University, Mississippi State.*

Due to the inherent qualitative differences between broiler and spent hen meat, the spent hen meat has created a difficulty in its effective disposal. The industry is actively seeking new and alternative uses for spent hens. Proteins are the best sources of flavor because of their amino acids, peptide, and nucleotide components. Protein hydrolysates are the main products derived from protein hydrolysis and have been used specially for flavoring purposes, as savory flavors or taste enhancers. Fine ground spent hen breast meat and water (1:10 or 1:2) were blended and hydrolyzed with either Papain + Protease (P+A, 0.5% (w/w) of raw meat weight for each enzyme) or Papain + Protease + Bromelain (P+A+B, 0.33% (w/w) of raw meat weight for each enzyme) at their optimal hydrolyzing conditions in the water bath at 50°C for four hours. The enzyme activity was terminated by placing the reaction bottles in boiling water for 15 min. After cooling, either whole hydrolysates or

filtrates were used for product preparations. Freeze-drying and evaporation methods were used in preparing hydrolysate powders or paste accordingly. Yields and microbiological analyses of final products were measured.

Yields of white light and fine freeze-dried powders from P+A and P+A+B hydrolysate prepared at 1:10 (meat: water) filtrates were 22.8% (W/W) and 23.0% (W/W), respectively. Yields of freeze-dried whole hydrolysates were 26.0% and 24.8% for P+A and P+A+B, respectively. Meanwhile, freeze-dried powders from P+A and P+A+B hydrolysate prepared at 1:2 filtrates had 26.7% and 26.2% of yield, respectively, while the yields of concentrated paste from whole hydrolysates were 47.8% and 51.0% for P+A and P+A+B, accordingly. Both freeze-dried filtered hydrolysate and the freeze-dried hydrolysate products had a total aerobic plate count ranging from log 2.59 cfu/g to 2.97 cfu/g. Similar range of total aerobes (log 2.74 to 2.84 cfu/g) was obtained in concentrated paste products. No *Salmonella* and *E. coli* /Coliform were detected from the prepared products.

Key Words: Spent Hen Meat, Enzymatic Hydrolysate, Flavoring Base

M43 *Listeria monocytogenes* prevalence and distribution within a poultry further processing plant over 12 months. M. E. Berrang*¹, R. J. Meinersmann¹, J. F. Frank², and D. P. Smith¹, ¹USDA-ARS-Russell Research Center, Athens, GA, ²University of Georgia, Food Science and Technology, University of Georgia, Athens.

In light of recent outbreaks and FSIS directives, it is important for poultry further processors to define the potential for cross contamination or cooked product re-contamination with *Listeria monocytogenes*. The objective of this study was to determine the prevalence of *L. monocytogenes* in a commercial poultry further processing plant. Furthermore, the effect of production shift activities on the spread of the organism was examined. One line producing fully cooked product was sampled 9 times over the course of a year (approximately every 6 weeks). Environmental sites were sampled by sponge or swab between sanitation and start up of production (pre-op) and again after an entire 8 hour shift was completed (post-op). Sample sites on both the raw and cooked side of the line included drain pipes, drain covers and condensate drip tubes from overhead coolers. Further pre-op and post-op sampling was conducted on cooked product contact surfaces. During the course of the production shift, purge from each bin of raw meat used for product formulation was collected and variable additional samples (16 per sample day) were collected in an effort to hunt for the organism. All samples were cultured using the FSIS *L. monocytogenes* protocol of preenrichment in *Listeria* enrichment broth and selective enrichment in Fraser broth. Darkened Fraser broth was plated on modified oxford agar and isolates were confirmed as *L. monocytogenes* using the FSIS cultural confirmation protocol. In 7 of 9 samplings at least one drain on the raw side was positive before production began. Raw side drains were positive at post-op in 8 of 9 trips. *L. monocytogenes* was never detected in cooked side drains or on product contact surfaces at pre-op; however, in 5 of 9 samplings one floor drain was positive at post-op. Despite such drain contamination, *L. monocytogenes* was not detected on any cooked product contact surface. *L. monocytogenes* was detected in raw meat used for product formulation in 8 of 9 samplings suggesting a possible source of plant contamination.

Key Words: *Listeria*, Processing, Environment

M44 Antimicrobial susceptibility patterns of *Salmonella* from fresh whole chicken carcasses. S. R. Ladely*¹, M. E. Berrang¹, P. J. Fedorka-Cray¹, M. Simmons², and D. L. Fletcher³, ¹USDA-ARS-Russell Research Center, Athens, GA, ²University of Georgia, Food Science and Technology, University of Georgia, Athens, ³Poultry Science, University of Georgia, Athens.

Salmonella is frequently reported as a cause of food-borne illness. The emergence of antimicrobial resistant *Salmonella* associated with food animals and their products has heightened concerns regarding antimicrobial use in food animal production. Eighty *Salmonella* isolates recovered from fresh whole chicken carcasses purchased at retail outlets were examined for susceptibility to 18 antimicrobials. Fifteen serotypes were identified; predominant serotypes included; *S. Heidelberg* (25%), *S. Typhimurium* var. *copenhagen* (18.75%), *S. Kentucky* (17.5%), *S. Berta* (11.25%), and *S. Hadar* (8.75%). Across all serotypes, 43.75% of the isolates were resistant to one or more antimicrobial. Fourteen

resistance patterns were observed among the isolates. Among these isolates, 22.5% were resistant to 3 or fewer antimicrobials, 16.25% were resistant to 4-6 antimicrobials, and 5.0% were resistant to 7 or more antimicrobials. Across all serotypes, resistance was most commonly observed to tetracycline (25%), ampicillin (22.5%), streptomycin (21.25%) and cephalosporin derivatives (cephalothin 18.75%, ceftiofur 16.25%, and cefoxitin 15%). Resistance patterns tended to group by serotype, however, 3 resistance patterns were common among different serotypes. The prevalence of antimicrobial resistance varied by serotype, ranging from 20% for *S. Heidelberg* to 100% for *S. Hadar*. All 7 *S. Hadar* isolates were resistant to 1-2 antimicrobials, 4 of 20 *S. Heidelberg* isolates were resistant to 3 or fewer antimicrobials, 10 of 15 *S. Typhimurium* var. *copenhagen* isolates were resistant to 4-5 antimicrobials, 7 of 14 *S. Kentucky* isolates were resistant to 1-7 antimicrobials, and 3 of 9 *S. Berta* isolates expressed resistance to 9-11 antimicrobials. These data indicate that *Salmonella* recovered from retail poultry carcasses may be resistant to multiple antimicrobials, and that resistance among these isolates varies by serotype.

Key Words: *Salmonella*, Antimicrobial Resistance, Chicken

M45 Influence of irradiation and storage on the quality of ready-to-eat turkey breast rolls. M. Zhu*, A. Mendonca, E. J. Lee, and D. Ahn, Iowa State University, Ames.

Influence of irradiation and storage on the quality of ready-to-eat (RTE) turkey breast rolls was investigated. Commercial oven roasted turkey breast rolls purchased from local stores were sliced and vacuum packaged. The sliced samples were randomly divided into three groups and irradiated at 0, 1.0, or 2.0 kGy using a Linear Accelerator. Color, 2-thiobarbituric acid reactive substances (TBARS), sensory characteristics and volatiles were measured at 0, 7 and 14 days of storage. Irradiation increased color a*-value of turkey breast rolls. TBARS values were not influenced by irradiation and storage. The production of acetaldehyde increased with storage time and irradiation dose. Irradiation also increased the production of 3-methyl butanal and 2-methyl butanal, which were suggested to be radiolytic product of leucine and isoleucine, respectively. However, there was no difference in hexanal content. Both 1.0 and 2.0 kGy irradiation greatly increased the amount of dimethyl disulfide. Irradiation also induced other sulfur compounds but at lower amounts. Irradiation of RTE turkey breast, especially at 2.0 kGy, significantly increased the production of benzene. The production of toluene in turkey breast was increased but to a less extent. Since both benzene and toluene have negative effects on health, their formation during irradiation warrants further studies to control the formation of these compounds. Sensory panelists pointed out that both sulfury odor and flavor of turkey breasts irradiated at 2.0 kGy were stronger than those of non-irradiated, but the sulfury odor and flavor of samples treated at 1.0 kGy were not significantly different from those of non-irradiated control. It was concluded that irradiation significantly influenced the odor and flavor of RTE turkey breast rolls under vacuum packaging conditions. Therefore, strategies to prevent negative changes in the quality of irradiated RTE turkey breast roll are needed.

Key Words: Ready-To-Eat Turkey Breast Roll, Irradiation, Volatiles and Sensory Characteristics

M46 Effects of extended storage on egg quality factors. D. R. Jones* and M. T. Musgrove, Russell Research Center, Poultry Processing and Meat Quality Research Unit, USDA-ARS, Athens, GA.

Eggs were collected from a single in-line processing facility once a week for three weeks (replicates). All eggs were stored at 4C and 80% RH for the 10 wk. Analyses began the day after collection and continued each week of storage. Two dozen eggs were examined for egg weight, albumen height, Haugh unit, shell strength, and vitelline membrane strength. Pooled egg yolks were analyzed for color values. Eggs from the second replicate were significantly ($P < 0.0001$) heavier than the other replicates by an average of 3 g. During storage, egg weight decreased ($P < 0.0001$) from approximately 61 g to 57 g after 10 wk of storage. Albumen height was approximately 2 mm higher for the eggs in replicate two compared to the other replicates ($P < 0.01$). On average, albumen height decreased with extended storage ($P < 0.0001$) from 7.05 mm to 4.85 mm. Haugh unit values decreased during cold storage from 82.59 to 67.43 ($P < 0.0001$). There were no differences between replicates for Haugh unit values. No differences were detected for shell strength

between replicates or during extended storage. A significant difference ($P < 0.05$) was found in detectable force required to break the vitelline membrane between treatments. This difference was less than 0.05 g. The elasticity of the vitelline membrane decreased during storage ($P < 0.01$) remaining low after 6 wk. Significant differences were detected for L^* , a^* and b^* values. While numerically these differences existed, they were below the degree detectable by the human eye. Therefore, these differences would have no effect on consumer perceptions. Extended cold storage did lead to decreases in egg weight, albumen height and Haugh units. Average Haugh unit values were still within the range of A grade. Shell strength was not affected by the extended storage. Vitelline membrane elasticity also decreased which could lead to yolks more easily rupturing as consumers cracked the eggs.

Key Words: Egg, Storage, Quality

M47 Chemical analyses of commercial shell egg wash water collected from three different operations. J. K. Northcutt*, M. T. Musgrove, and D. R. Jones, *USDA, Agricultural Research Service, Russell Research Center, Athens, GA.*

A study was conducted to evaluate egg wash water from in-line shell egg processing facilities (Plants X, Y and Z). Water samples were collected from the tap, washer 1 (W1) and washer 2 (W2) in each facility. Samples were evaluated for chemical oxygen demand (COD), total Kjeldahl nitrogen (TKN), total suspended solids (TSS), total dissolved solids (TDS), pH, temperature, chlorine and soluble iron. Values for COD, TKN, pH, temperature and chlorine varied significantly among the facilities ($P < 0.05$). Sample (tap, W1 or W2) had a significant effect on COD, TKN, TSS, TDS, pH, temperature, chlorine and soluble iron ($P < 0.05$). COD values for both W1 and W2 followed the order of: Plant Z > Plant X > Plant Y. Wash water had COD values that ranged from 7300 mg/L to 1765 mg/L. TKN values for the wash water ranged from 302 mg/L to 81 mg/L. Highest values for TSS and TDS occurred in W1 (601 mg/L and 5287 mg/L, respectively) as compared to W2 (401 mg/L and 3087 mg/L, respectively). Wash water pH varied from pH 11.4 (W1, Plant Z) to pH 10.0 (W2, Plant X). No difference was found in the pH of tap water which averaged from pH 6.1 to 6.7. Wash water temperature ranged from $44.1 \pm 0.1^\circ\text{C}$ to $39.7 \pm 0.3^\circ\text{C}$, and was generally highest in W2 samples from all three plants. Chlorine levels in the wash water for Plant Y (0.89 mg/L, W1; 0.91 mg/L, W2) were significantly lower ($P < 0.05$) than the levels for Plant X (2.72 mg/L, W1; 2.62 mg/L, W2) or Plant Z (4.5 mg/L, W1; 2.35 mg/L, W2). Chlorine levels in the tap water were similar among the facilities and ranged from 0 to 0.15 mg/L ($P < 0.05$). Average values of soluble iron (ferrous) in the egg wash water were 0.29 ± 0.02 mg/L to 1.60 ± 0.29 mg/L; however, iron levels were found to be above the 2.0 mg/L guideline in W1 for Plant X during one of the sample collections. Data provided by the present study may be useful for identifying process deficiencies and minimizing organic and inorganic discharge loads in the waste stream.

Key Words: Shell Eggs, Egg Processing Water, Chemical Analyses

M48 Evaluation of carcasses obtained from broilers fed with ostrich oil and/or soybean oil as energy source. W. Martinez, E. Posadas, E. Avila, and M. P. Castañeda*, *Universidad Nacional Autónoma de México, Salvador Díaz Mirón s/n, Col Zapotitlan, México D.F.*

Ostrich oil is a waste product from the production of leather and meat on Mexican ranches. The objective of this study was to evaluate carcass yield, breast, leg and thigh yields, pigmentation, and fatty acid profiles in meat obtained from broilers fed with ostrich oil and/or soybean oil.

Four hundred twenty broiler chickens (Ross x Ross) were randomly distributed in four treatments with five trials of 21 chickens each. The treatments were as follows: T1 (5% soybean oil in both feeding phases), T2 (5% ostrich oil in both feeding phases), T3 (5% soybean oil in starter feed and 5% ostrich oil in finisher feed) and T4 (5% ostrich oil in starter feed and 5% soybean oil in finisher feed). At 49 days, the birds were processed under commercial conditions and pigmentation, carcass yield, breast, leg and thigh yield, and fatty acid profile (Folch's method) were determined. There were no statistical differences among treatments ($P < 0.05$) for the weight of the carcass, weight of carcass with viscera, carcass yield and breast, leg and thigh yield, and yellowness value. The redness value was not significantly different after picking; however, after chilling T1 (7.79) was only significantly higher than T2 (4.962). The lightness value following chilling indicated T4 (71.79) was significantly higher than T1 (69.16). The results from the fatty acids profile indicated T3 and T4 had the highest content of lipids and saturated fatty acids in breast, leg and thigh. T4 had the highest content of monounsaturated fatty acids in breast and the T3 the highest in leg and thigh compared to the remaining treatments. The content of omega-3, omega-6 indicated that T4 had the highest concentrations in the breast and leg-thigh meat samples compared to the remaining treatments. T4 was significantly higher in omega-9 in the breast meat and T3 was significantly higher in omega-9 in the leg-thigh meat samples compared to the remaining treatments. The results obtained in the present study suggest that ostrich oil and soybean oil increased the polyunsaturated fatty acids levels without affect the yield and pigmentation levels. The ostrich oil is a viable option in the broiler feed as energy source.

Key Words: Ostrich Oil, Soybean Oil, Carcass

M49 Effects of post-defeathering electrical stimulation on moisture retention characteristics of broiler carcasses and phosphate-marinated breast fillets. L. L. Young*¹, D. P. Smith¹, J. A. Cason¹, R. J. Buhr¹, and J. M. Walker², ¹USDA, Athens, GA, ²Stork-Gamco, Inc., Gainesville, GA.

Processing technologies sometimes interact in a way that alters their individual functionalities. The objective of this study was to evaluate effects of simultaneous application of two such technologies, electrical stimulation (ES) of broiler carcasses immediately post-defeathering to improve texture of early harvested breast fillets and marination of breast fillets in sodium tripolyphosphate (STPP) solution to enhance moisture absorption and retention. Mixed-sex broiler chickens were conventionally slaughtered. Half were stimulated by pulsed electrical current (220 VAC, 2 s on, 1 s off) for 90 s immediately after defeathering and prior to evisceration and half remained unstimulated. After chilling, breast fillets were excised. Half the fillets from each stimulation treatment were marinated in STPP and half without STPP. Chiller water absorption by intact carcasses and pH and moisture absorption and retention by marinated fillets were observed. ES slightly depressed chiller water absorption by the carcasses (4.0% v. 4.6%), but its effect on breast fillets was much greater. ES improved marinade absorption by fillets (11.1% v. 9.6%) but did not affect cooking loss. Although the STPP increased fillet pH somewhat (6.28 v. 6.22), it had little effect on marinade absorption (10.1% v. 10.6%); however, fillets marinated without STPP lost more moisture in cooking than those marinated without STPP (17.6% v. 12.4%). No significant statistical interactions between ES- and STPP-treatments were observed in this study. These results suggest that ES affects chiller water absorption by broiler carcasses only slightly and has little effect on the efficacy of STPP in enhancing moisture absorption and retention by marinated breast fillets.

Key Words: Electrical Stimulation, Polyphosphate, Meat

Meat Science and Muscle Biology

M50 DFD-like (dark, firm, dry) meat in a broiler commercial plant. J. Schneider^{2,3}, S. H. I. Oda¹, A. L. Soares¹, E. I. Ida*¹, P. D. Guarnieri², R. Olivo³, and M. Shimokomaki^{1,2}, ¹Department of Food and Drug Technology, Londrina State University, Londrina, PR, Brazil, ²Food Science Graduate Program, Faculty of Pharmaceutical Sciences, São Paulo University, São Paulo, Brazil, ³Globalfood Advanced Food Technology, Alberto Sampaio, São Paulo, S, Brazil.

It has been established there is occurrence of PSE (Pale, Soft, Exudative) chicken meat in commercial plants in Brazil. Attempts to control

its development are currently applied and one of them consists on the use of water shower spray to lower the chicken body temperature. This manoeuvre has been shown to be successful but it seems to be one cause of the appearance of DFD-like meat. The objective of this work was to evaluate the occurrence of DFD-like poultry meat and its functional properties in a commercial plant. Commercial Ross chickens were divided into two groups: Untreated Group (UG) (n=811) and Treated Group (TG) (n=425), without and with water shower treatments, respectively. Carcasses were refrigerated through water chiller and af-

ter deboning, fillet (*Pectoralis major*) samples were stored for 24h at 4°C and pH, L*, drip loss, cook loss, emulsion capacity were evaluated. Samples were classified as DFD-like, PSE and Normal meat based on the previous established parameters such as L*#880444.0 as DFD-like, L*#880553.0 as PSE and 44.0#8804L*#880453.0 as Normal. The results obtained for UG were 0.37, 21.95 and 77.68% for DFD-like, PSE and Normal meat samples, respectively while for TG the incidence was 0.94, 5.41 and 93.64% for DFD-like, PSE and Normal meat samples, respectively. Birds preslaughter treatment with water shower decreased PSE incidence and increased DFD-like occurrence reflecting the glyco-gen depletion. DFD-like meat showed pH values of 6.15 (± 0.23) similar to the Normal samples 5.93(± 0.26). In addition, DFD-like samples presented the values of L* 43.2 (± 0.53), drip loss 1.11% (± 1.01), cook loss 22.88% (± 2.65), emulsion capacity 0.70% (± 0.12) significantly different (p#88040.05) from the Normal samples of L*49.6 (p#88041.90), drip loss 2.55% (± 2.16), cook loss 25.38% (± 3.96) and emulsion capacity 0.78% (± 0.20). Finally, it is recommended DFD-like meat to be used as raw material to produce emulsified meat products with technological and cost benefits to the industries.

Key Words: Functional Properties, GLycogen Depletion, Abnormal Meat Color

M51 Biochemical and ultrastructural evaluation of PSE (pale, soft, exudative) broiler breast meat in a commercial plant. M. Shimokomaki^{1,2}, A. L. Soares¹, P. D. Guarnieri², R. Olivo³, E. I. Ida¹, R. M. G. Macedo¹, and J. Schneider^{2,3}, ¹Department of Food and Drug Technology, Londrina State University Londrina, PR Brazil, ²Food Science Graduate Program, Faculty of Pharmaceutical Sciences, São Paulo University, São Paulo, SP, Brazil, ³Globalfood Advanced Food Technology, Alberto Sampaio, São Paulo, SP, Brazil, ⁴Maringa State University, Maringa, PR, Brazil.

PSE meat is becoming a problem for the poultry meat industry and it has been demonstrated that it is the consequence of myofibril protein denaturation caused by pre-slaughter handling, particularly physical stress which promotes a rapid muscle pH decline at a relatively high body temperature. It is becoming a routine practice in Brazilian poultry industries to have water spray and air ventilation treatments just before broiler slaughter. The objective of this work was to investigate the influence of these practices on the quality of breast meat (*Pectoralis major*). The characteristics studied were the physicochemical and ultrastructural changes promoted by the biochemical/physiological events during the onset of rigor mortis. Commercial Ross chickens were divided into two groups: Untreated Group (UG) (n=608) and Treated Group (TG) (n=611), without and with water shower treatment, respectively. Drip loss was 3.74% for UG and 2.24% for TG and cook loss was 32.01% for UG and 28.04% for TG (p#88040.01). pH values were 5.85 (± 0.08) and 6.06 (± 0.10) for UG and TG, respectively while colour values were L*53.11 (± 1.50) and 48.78 (± 1.72) for UG and TG respectively, measured after 24h post-mortem both significantly different (p#88040.01). Histological studies of the PSE samples from UG birds 72h post-mortem revealed under light microscopy a shrinking of muscle cell diameter by approximately 10% in relation to TG samples (p#88040.01) and an extra cellular enlargement of endomysium and perimysium sheaths. By electron microscopy of PSE meat, Z-lines appeared fragmented, A-bands including the M-line disappeared and a super-contraction of sarcomeres was observed, indicating that proteins were adversely affected by heat stress. These results showed that water shower spray just before slaughter prevented chicken PSE meat development as determined bio-chemically and ultrastructurally.

Key Words: Breast Meat, Microscopic Evaluation, Myofibril Proteins

M52 Effect of feeding program and sex on productive performance and carcass quality of Iberian crossbred pigs. M. P. Serrano¹, D. G. Valencia¹, R. Lázaro^{*1}, M. Nieto², and G. G. Mateos¹, ¹Universidad Politécnica de Madrid, Ciudad Universitaria sn, ²Copese S.A. Conde de Sepúlveda 24.

A total of 192 crossbred (Duroc sire x Iberian dam) pigs were used to study the influence of the feeding program (energy level in isonutritive diets per kcal of NE during the growing period and source of added fat during the finishing period) on performance and carcass quality of Iberian-cross pigs. From 29 to 110 kg BW there were 6 treatments with 3 levels of energy (2.07, 2.21, and 2.35 Mcal NE/kg) and 2 sexes (castrated males and castrated females). From 110 to 145 kg half of the

pigs received a diet with 6% animal fat and the other half the same diet but with 6% olive soapstocks instead of animal fat. Each treatment was replicated eight times from 29 to 110 kg and four times from 110 to 145 kg and the experimental unit was a pen with 4 pigs. At the end of the trial males tended to grow more than females (846 vs 817 g/d; P#88040.10). Also, an increase in NE concentration of the diet tended to improve feed efficiency (3.99, 3.93, and 3.83 g/d, for low, medium, and high NE diets, respectively; P#88040.10). From 110 to 145 kg BW average daily gain was higher for males than for females (926 vs 875 g/d; P#88040.05) but source of fat did not affect any trait. Males had longer carcasses (86.7 vs 85.1 cm; P#8804 0.001), more proportion of shoulder (14.05% vs 13.82%; P#88040.05), and heavier loins (4.78 kg vs 4.46 kg; P#88040.01) than females; but carcass and ham yield were similar. Backfat and tarsus bone diameter were greater for males than for females (64.4 vs 62.0 cm and 17.5 vs 17.2 cm, respectively; P#88040.05). Experimental treatment did not affect drip losses or pH or temperature of *m. semimembranosus* at 45 min or 24 h *post mortem*. We conclude that an increase in NE of the diet in the growing period improved feed efficiency less than expected and that the type of fat did not influence fattening performance. Both sexes could be used to produce Iberian-cross carcasses with little differences in productivity and carcass quality when slaughtered at same BW.

Key Words: Iberian pigs, Net energy, Carcass quality

M53 Effect of sex and slaughter weight on productive performance and carcass quality of Iberian crossbred pigs. M. P. Serrano¹, D. G. Valencia², R. Lázaro^{*3}, J. Viguera⁴, M. Nieto⁵, and G. G. Mateos⁶, ¹Universidad Politécnica de Madrid Ciudad Universitaria sn, ²Copese S.A. Conde de Sepúlveda, 24.

A total of 360 crossbred (Duroc sire x Iberian dam) pigs were used to study the influence of sex (castrated males, CM, castrated females, CF, and entire females, EF) and slaughtered weight (145 and 155 kg BW) on performance and carcass quality. Each of the six treatments were replicated four times and the experimental unit was pen (15 pigs/pen). At the end of the trial pigs slaughtered at 155 kg BW ate more feed (2808 vs 2630 g/d; P#88040.01) and tended to be less efficient (3.65 vs 3.50 g/g; P#88040.10) than pigs slaughtered at 145 kg BW. Also, EF ate less and had better feed efficiency than CF or CM (2598 vs 2733 and 2825 g/d and 3.38 vs 3.67 and 3.68 g/g; P#88040.01, respectively). Pigs slaughtered at 155 kg had more carcass yield and tended to have higher trimmed ham yield than pigs slaughtered at 145 kg. Carcasses of pigs slaughtered at 155 kg BW presented higher pH (P#88040.01) and temperature (P#8804 0.001) at *m. semimembranosus* at 45 min or 24 h *post mortem* than carcasses of pigs slaughtered at 145 kg BW. Entire females had less carcass yield (80.0 vs 80.6 and 80.8%; P#88040.01) and carcass fat (55.6 vs 63.0 and 61.9 mm at P2 and 47.9 vs 55.0 and 54.4 mm at *m. Gluteus medius*; P#88040.001) than CM or CF. Also, EF had more loin yield at 24 h *post mortem* (4.0 vs 3.5 and 3.6% for cm and cf, respectively; P#88040.001) and higher trimmed hams and shoulders yields (18.2 vs 16.8 and 17.2% and 11.6 vs 10.9%; P#88040.001, respectively) than CM and CF. Entire females and CM had higher proportion of shoulders at 6 h *post mortem* than CF (17.1 and 16.9 vs 16.0%; P#88040.05). Castrated males had higher pH of *m. semimembranosus* at 45 min or 24 h *post mortem* (P#88040.001) than EF or CF. We conclude that EF had better productive performance and yield of primal cuts than CF or CM. Nevertheless entire females had less carcass yield than CF or CM. It is recommended to study in detail the possibilities of using EF instead of CF in commercial production of Iberian-cross pigs.

Key Words: Iberian Pigs, Sex, Carcass Quality

M54 Early postmortem pH influences proteolysis of cytoskeletal proteins during aging in porcine longissimus muscle. G. Bee^{*2}, S. M. Lonergan¹, and E. Huff-Lonergan¹, ¹Iowa State University, ²Swiss Federal Research Station for Animal Production and Dairy Products, 1825 Posieux, Switzerland.

The objective of this study was to determine the extent to which early postmortem (PM) pH decline influences proteolysis of the intermediate filament protein desmin and the costameric protein talin in the longissimus muscle (LM) of pigs from two genetic lines (A and B). Based on the 3 h pH (H = pH > 6.0; L = pH < 5.7) PM, 10 pigs per line and pH group were selected from 120 pigs. The average 3 h pH within pH group was 6.19 (H) and 5.41 (L) in line A and 6.27 (H) and 5.47 (L) in line B. LM samples were collected 24, 48, 72 h, and 7 d PM and percent

drip loss was measured after 1, 2, and 7 d PM. These samples were also used to monitor desmin and talin degradation by immunoblotting. The ratio (relative intensity of the 53 kDa band of desmin and 225 kDa band of talin in the samples/intensity of desmin or talin in a reference) was used as a measure of proteolysis. Drip loss at all time points was lower ($P < 0.01$) in the H-pH (d 1: 1.62%; d 2: 1.80%; d 7: 2.99%) than in the L-pH group (d 1: 3.11%; d 2: 3.40%; d 7: 4.72%) regardless of line. Drip loss was lower ($P < 0.01$) in line B (d 2: 2.04%; d 7: 3.14%) than line A (d 2: 3.15%; d 7: 4.56). Independent of the line, proteolysis of desmin was faster ($P < 0.03$) after 1 and 2 d in the LM from the H-compared with those from the L-pH group. At d 7, relative abundance of intact desmin was 45% lower ($P < 0.01$) in the LM from pigs of line B than line A. Compared to the L-pH group, relative abundance of talin determined in the LM 24, 48, 72 h, and 7 d PM decreased ($P < 0.03$) at a faster rate in the H-pH group. Line effects were found at 48 h PM with 46% less intact talin abundance in the LM of pigs from line A compared with those from line B. Disappearance of desmin was positively correlated ($r = 0.51$; $P < 0.01$) with the disappearance of talin. Furthermore, proteolysis of both proteins was positively correlated ($P < 0.01$) with percent drip loss. Degradation of cytoskeletal proteins is related to early postmortem pH and improves water-holding capacity.

Key Words: pH, Proteolysis, Water-holding capacity

M55 Oxidation, ionic strength, and pH affect porcine skeletal muscle calpain and calpastatin activity. K. R. Maddock*, E. Huff-Loneragan, L. J. Rowe, and S. M. Lonergan, *Iowa State University, Ames.*

The objective was to evaluate how oxidation affects activity of μ - and m-calpain and their inhibition by calpastatin at different pH and ionic strengths. Purified porcine skeletal muscle μ - or m-calpain (0.45 units) were incubated in the presence of calpastatin (0, 0.15, or 0.30 units) at pH 7.5, 6.5, or 6.0 with either 165 mM NaCl or 295 mM NaCl. The reactions were initiated with addition of CaCl_2 (100 μM for μ -calpain; 1 mM for m-calpain). Calpain was incubated with the fluorogenic peptide Suc-Leu-Leu-Val-Tyr-AMC (170 μM). Either 0 or 0.160 μM H_2O_2 was added to each assay. Activity was measured at 60 min. In a second experiment, calpain was incubated with highly purified porcine myofibrils (4 mg/ml) under conditions described. Either 0 or 100 μM H_2O_2 was added immediately prior to the addition of calpain. Degradation of desmin was determined with immunoblotting at 2, 15, 60, 120 min. Fluorescence activity was greatest ($P < 0.01$) at pH 6.5 for μ -calpain and 7.5 for m-calpain. No activity of m-calpain was observed at pH 6.0 at either ionic strength or at pH 6.5 at 295 mM NaCl and 0.160 μM H_2O_2 . In general μ - and m-calpain were less active at 295 mM NaCl than at 165 mM NaCl ($P < 0.01$). Oxidation decreased activity of both μ - and m-calpain ($P < 0.01$) at all pH and ionic strength conditions and decreased inhibition of μ - and m-calpain by calpastatin ($P < 0.01$). At pH 6.0, degradation of intact desmin was delayed compared to pH 7.5 or 6.5 and at 295 mM NaCl compared to 165 mM NaCl. Oxidation decreased proteolytic activity of μ -calpain against desmin at pH 6.0 and m-calpain at all pH conditions. Inhibition of μ -calpain by calpastatin was decreased by oxidation at pH 7.5 and 6.5. This is consistent with the observation that oxidation in the presence of calpastatin results in more proteolysis of desmin. Taken together, these results suggest that calpastatin may limit the possibility of oxidation-induced inactivation of μ -calpain.

Key Words: Calpain, Calpastatin, Oxidation

M56 The use of creatine as a means of improving the belly/bacon quality of market barrows fed 4.5 g/ton Paylean®. C. A. Stahl*, M. S. Carlson, T. B. Schmidt, G. Rentfrow, E. K. Burger, and E. P. Berg, *University of Missouri-Columbia, Columbia.*

The objective of this study was to determine if dietary supplementation of creatine monohydrate (in conjunction with high glycemic carbohydrate) influences the belly/bacon quality of market hogs fed 4.5 g/ton Paylean®. Barrows ($n = 128$; 85 kg) were blocked by weight and allotted to one of 16 pens (8 pigs/pen; 4 reps/treatment) using a completely randomized design. A pelleted corn-soybean diet containing 4.5 g/ton Paylean® (PAY) was tested against a positive control (PCON; pelleted corn-soybean diet formulated to meet or exceed the nutrient requirements of the growing pig), and pelleted corn-soybean diets containing

0.92% creatine and 2.75% dextrose (COMBO) and a combination of 4.5 g/ton Paylean®, 0.92% creatine, and 2.75% dextrose (PAYPLUS). Barrows were humanely harvested following 27 d on test. Fresh pork bellies ($n = 64$, 4/replicate pen) were obtained from the fabrication line and weighed. Bellies thickness was recorded as the average depth of eight separate quadrants. Uncooked bellies were then pumped using a commercial brine solution, weighed, hung by a bacon comb, placed on smokehouse trucks, and heat processed according to plant protocol. The following morning, individual bacon slabs were removed from the cooler, weighed, pressed and sliced. Following the removal of comb marks and incomplete slices, individual bacon slabs were weighed to determine slicing yield and divided into five separate sections. Bacon slices (1/section, 5/belly) were weighed and evaluated for subjective fracture analysis (shatter) and cooking loss. Treatment did not influence belly weight, average belly thickness, smokehouse yield, slicing yield, or shatter ($P > 0.05$). However, bacon slice cooking loss was lowest for PAY bellies (PAY: 56.84, PCON: 60.96, COMBO: 60.92, PAYPLUS: 59.75 +/- 0.97%, $P < 0.05$). These findings suggest that feeding creatine in conjunction with a high glycemic carbohydrate has no measurable influence on the belly/bacon quality of market barrows fed 4.5 g/ton Paylean® 27 d pre-harvest.

Key Words: Creatine, Paylean®, Bacon

M57 Physical parameters of lamb meat as affected by aging time. J. Zapata*, *Universidade Federal do Ceara.*

Fresh meat quality is generally associated with the physical aspect of the cuts at the retail market level. Functional properties of the meat, on the other hand, are important parameters to be considered by the further processing industry. The purpose of this study was to determine the effect of aging selected cuts (leg and loin) from tropical lambs on physical characteristics (pH, color and shear force) and functional properties (cooking losses, water holding capacity and emulsifying capacity) of the meat. Meats from the loin (*longissimus dorsi* muscle) and the leg (*semimembranosus* and *biceps femoris* muscles) of tropical lambs with average weight of 35kg were aged for 1, 7, 14 and 21 days at 1C. Meat pH values increased from 5.48 in day one to 5.56 on day 21 and showed a significant ($P < 0.05$) correlation with aging time. The color of the meat was not significantly affected by aging time. Shear force decreased from 8.86kg in day 1 to 6.77kg in day 21 of aging and showed a close correlation with aging time. A significant ($P < 0.05$) correlation of cooking losses with aging time was found in the meat with values increasing from 26.96 to 34.92% throughout the aging period. Meat water holding capacity varied ($P > 0.05$) from 33.85% on day 7 of aging to 29.82% on day 21. Emulsifying capacity of lamb meat decreased ($P > 0.05$) slightly during the aging period from 92.39 to 91.80%. It can be concluded that aging tropical lamb meat for 21 days at 1C does not affect color, water holding capacity or emulsifying capacity. The increase in meat pH, and cooking losses as well as the decrease in shear force are dependent on aging time and regression curves can be drawn for these attributes.

Key Words: Cooking Losses, Water Holding Capacity, Emulsifying Capacity

M58 Extracellular matrix (ECM) properties of lamb skeletal muscle as related to age and muscle. F. Filetti, G. Maiorano*, A. Ciarlariello, M. Gambacorta, and A. Manchisi, *University of Molise Campobasso, Italy.*

Decorin (D), being expected to facilitate the alignment of intramuscular collagen (IMC) fibers, could be followed by a rapid synthesis of hydroxylysylpyridinoline (HLP) crosslinks, which are regarded as main factors contributing to meat tenderness. To study relationships among D, IMC and HLP in skeletal muscle ECM, 24 Italian Merino male lambs were slaughtered in groups of equal number, at 5, 30, 50 and 70 d of age. *Longissimus dorsi* (LD), *semimembranosus* (SM) and *gluteobiceps* (GB) samples were lyophilized and hydrolyzed in 6N HCl for analysis of hydroxyproline (Hyp) and HLP. IMC was calculated assuming that it weighed 7.25 times the measured Hyp weight. HLP was quantified by RP-HPLC. Raw muscles were analyzed for D by immunoblotting with a polyclonal antibody to human D (1:5,000) and an alkaline phosphatase conjugated goat anti-rabbit IgG (1:30,000). D was quantified by densitometry. ANOVA was performed and relationships among variables were analyzed with simple linear regression. Muscle affected IMC ($P < 0.05$) and HLP ($P < 0.001$) amounts, and HLP/IMC ratio ($P < 0.05$). LD compared to SM and GB had lower amounts of IMC (22.0a, 29.1b,

31.9b $\mu\text{g}/\text{mg}$, respectively) and HLP (2.7a, 4.7b, 4.0c $\mu\text{g}/\text{mg}$, respectively). IMC was less mature in LD and GB than in SM, as showed by the HLP/IMC ratio (0.09a, 0.09a, 0.12b mol/mol, respectively). Muscle also affected ($P < 0.001$) D expression, which was higher in LD than in SM and GB (20.1a, 13.0b, 13.6b RDU/mg, respectively). Age clearly ($P < 0.001$) influenced ECM. In the first month of age, a marked reduction was found on IMC (66.0a, 28.5b, 25.4b, 26.1b $\mu\text{g}/\text{mg}$ at d 5, 30, 50, and 70, respectively) and HLP (7.2a, 3.1b, 3.4b, 4.2c $\mu\text{g}/\text{mg}$) amounts. In the same period a sudden rise was detected on D (11.6a, 19.4b, 14.9a, 14.6a RDU/mg), temporally followed by an increase in IMC maturation (0.08a, 0.08a, 0.09a, 0.11b moles HLP per mol IMC). D correlated with HLP muscle amount ($r = -0.61$; $P < 0.001$) and ratio to IMC ($r = -0.37$; $P < 0.01$) confirming that a decorin/crosslink relationship may exist.

Key Words: Lamb, Age, Skeletal Muscle Extracellular Matrix

M59 Carcass and meat quality in three varieties of rainbow trout (*Oncorhynchus mykiss*). A. L. Rentería Monterrubio^{*1}, J. A. García Macías¹, and M. Espinosa^{2, 1} *Universidad Autónoma de Chihuahua, Periferico Francisco R. Almada. Km 1, Chihuahua, Chihuahua, 2Asociación de Productores de Trucha, Región de Madera, A. C..*

240 rainbow trouts of 3 varieties, Danish (80), Mexican (80) and American (80) were evaluated, in four weight groups: 175 - 224 g (1), 225 - 274 g (2), 275 - 324 g (3) and 325 - 375 g (4). The trouts came from farms of the Asociación de Productores de Trucha, Región de Madera, A.C. Measurements of weight and dissections of trouts were made to obtain the carcass quality characteristics. The effect of weight and trout variety were analyzed with a random design in a factorial arrangement of 3 x 4 with PROC GLM procedure of SAS. The greatest carcass yield occurred in the Mexican at 3 (88.35) and 4 group (87.34) and the Danish in group 1 (87.05) and 2 (86.34) ($P < 0.05$). The greatest fillet yield was registered in the Danish group 1 (53.17), in the American group 2 (53) and 4 (54.67) and in the Mexican group 3 with 54.36% ($P \# 88040.05$). Meat quality was evaluated, in luminosity (L^*), the Danish group 2 showed the lowest L^* (43.02) and the American group 3 the highest (47.53) ($P < 0.06$). The Mexican group 1 pH was the highest at 7.25 ($P \# 88040.05$), with the American group 2 at 7.14, 3 at 6.98 and 4 at 6.79 ($P < 0.05$). The four Danish weight groups water holding capacity were the best (51.19, 54.65, 52.16 and 51.42, respectively) ($P \# 88040.05$). The highest electrical conductivity was obtained from the Danish group 3 (13.32) and the lowest with the American group 4 (9.42) ($P \# 88040.05$). The greatest percentages of crude protein were seen with Danish group 1 (20.12), 2 (20.82) 4 (21.58), and the Mexican group 3 (21.50) ($P \# 88040.05$). The Danish weight group 1, 2, 3 and 4 presented the lowest content of fat ($P \# 88040.05$) (2.64, 2.48, 2.66 and 2.98, respectively). It is concluded that the Danish group 1 and the Mexican groups 2, 3 and 4 are the most acceptable rainbow trout carcasses. Fillet commercialization is better in the American group 2 and 4 and the Mexicans weight group 3.

Key Words: Rainbow Trout, Carcass Quality, *Oncorhynchus mykiss*

M60 Effects of sedated-harvest on channel catfish fillet color, pH, and drip-loss. B. G. Bosworth* and D. J. Gregory, *Catfish Genetics Research Unit, USDA-ARS, Stoneville, MS.*

Stress and activity associated with harvest and transport of meat animals elicit physiological responses that negatively impact meat quality. Previous research with channel catfish demonstrated that sedation of fish during harvest with the anesthetic iso Eugenol (Aqui-S#8482) minimized detrimental physiological responses (lower muscle lactate and serum cortisol, higher muscle pH and ATP) compared to control fish. Our objectives were to determine the best method (N_2 gas, CO_2 gas, or electrical stun) for killing sedated fish prior to slaughter and to determine effects of sedated-harvest on fillet quality (color, pH, and drip-loss) during iced-storage. CO_2 was selected as the best method to kill sedated fish based on physiological responses of fish (higher muscle pH and lower blood lactate compared to N_2) and worker safety issues associated with use of electrical stunning during harvest. Two treatments were compared for fillet quality: sedated-harvest (fish sedated with 15 ppm iso Eugenol, then placed in ice slush with CO_2) and control (simulated industry conditions - fish harvested, placed in live-haul tanks at 0.8 kg L^{-1} for 2 h, then electrically stunned). Fish were processed, and fillets were placed in polyethylene bags, immediately chilled in ice slush, and stored on ice for 7 d. Fillets ($n = 10$ treatment/time/replicate) were measured for CIE color (L^* , a^* , b^*), pH, and percent drip-loss

(100*weight loss/initial weight). Two replicate trials were conducted and data were analyzed by ANOVA. Sedated-harvest fillets had lower L^* values than controls at 1 d (49.4 vs. 54.3, $p < 0.001$), 4 d (52.5 vs. 54.1, $p = 0.04$), and 7 d (53.9 vs. 54.9, $p = 0.03$); and lower a^* values at 4 d (0.1 vs. 1.2, $p = 0.02$) and 7 d (-1.0 vs. -0.3, $p < 0.001$). Sedated-harvest fillets had higher pH than controls at processing (7.52 vs. 6.47, $p < 0.001$) and 1 d (6.64 vs. 6.40, $p = 0.002$). Fillet drip-loss was lower in sedated-harvested fish than control fish at 1 d (0.32 vs. 1.36 %, $p < 0.001$), 4 d (0.80 vs. 2.85 %, $p < 0.001$), and 7 d (1.60 vs. 4.14 %, $p < 0.001$). Sedated-harvesting has the potential to improve fillet quality in farm-raised catfish.

Key Words: Catfish, Fillet, Quality

M61 Effect of sexual condition and slaughter weight on carcass traits from buffaloes finished in feedlot. A. M. Jorge^{*1}, C. Andrighetto², D. D. Millen³, and M. G. Calixto², ¹UNESP-FMVZ-DPEA-Botucatu, ²UNESP-FMVZ-PGZOO-Botucatu, ³UNESP-FMVZ-DPEA-Botucatu.

The objective of this work was to evaluate the carcass traits from intact and castrated buffaloes, of the Brazilian type, finished in feedlot and slaughtered at 450 and 500 kg of live weight. There was no significant difference between cold carcass yield of intact animals and castrated (52.4 vs 51.3%). A significant increase was verified in hindquarter and whole shoulder yield from intact males. Castrated animals had a higher forequarter and pistol style cut yield (due to the higher round yield and not a higher yield of spare ribs). There was no difference in the carcass length, longissimus dorsi area and back fat thickness among intact and castrated animals. Carcass back fat thickness from intact males (5.9 mm) was lower than castrates (7.1 mm). The backfat level of intact males was very close of the ideal limits considered by retailers and may contribute to reducing the resistance to slaughtering intact animals. No difference was observed for cold carcass yield (50.5 vs 52.2%), primal cut yield, carcass length, longissimus dorsi area (54.9 vs 58.3 cm²) and back fat thickness (5.3 vs 5.9 mm) from buffaloes slaughtered at 450 kg vs 500 kg of live weight, although heavier animals tended to present the higher values of longissimus dorsi area and back fat thickness.

Key Words: Backfat Thickness, Longissimus dorsi Area, Water Buffalo

M62 Quantitative carcass traits from buffaloes of three genetic groups finished in feedlot and slaughtered at different stages of maturity. A. M. Jorge^{*1}, C. Andrighetto², D. D. Millen³, and M. G. Calixto², ¹UNESP-FMVZ-DPEA-Botucatu, ²UNESP-FMVZ-PGZOO-Botucatu, ³UNESP-FMVZ-DPEA-Botucatu.

This work was conducted to study the quantitative carcass traits from 36 buffaloes, average live weight 330 kg and age 18 months, representing 12 Murrah (MUR), 12 Jafarabadi (JAF) and 12 Mediterranean (MED) finished in a feedlot setting. Four animals inside of each genetic group, were randomly assigned to initial slaughter. The 12 animals of each genetic group, were randomly assigned in three sub-groups of four animals and submitted to the following treatments, respectively: Maturity 1 (Slaughter Weight-1) - 400 kg LW; Maturity 2 (Slaughter Weight -2) - 450 kg LW; Maturity 3 (Slaughter Weight -3) - 500 kg LW. An ad libitum ration was used for all the animals, in that 50% of DMS were supplied by roughage. The empty body weight was determined after each pre-fixed slaughter of the animals through the sum of the total parts of the body. There were no differences ($P > 0.05$) among genetic groups and maturities regarding yield of hind and forequarters, whole shoulder and whole rump. Animals slaughtered at 400 kg LW had higher yield of pistola style cuts than 500 kg LW animals ($P < 0.05$), while 450 kg LW animals did not differ from others. It was observed that whole shoulder yield differed from one side of the carcass to the other. These differences may have been the result of a section of spares ribs left on one side. This may have involuntarily increased ribs proportionally larger in heavier animals.

Key Words: Mediterranean, Murrah, Water Buffalo

M63 Physical carcass composition and tissue relations from buffaloes of three genetic groups finished in feedlot and slaughtered at different stages of maturity. A. M. Jorge^{*1}, C. Andrighetto², D. D. Millen³, and M. G. Calixto², ¹UNESP-FMVZ-DPEA-Botucatu, ²UNESP-FMVZ-PGZOO-Botucatu, ³UNESP-FMVZ-DPEA-Botucatu.

This work was conducted to study the physical carcass composition from 36 buffaloes with 18 months of average age and average initial live weight (LW) of 330 kg, being 12 Murrah (MUR), 12 Jafarabadi (JAF) and 12 Mediterranean (MED) finished in feedlot. Four animals, inside of each genetic group, were randomly assigned to initial slaughter, as reference in the study of the empty body (EBW) and of the initial carcass. The 12 animals of each genetic group, were randomly distributed in three sub-groups of four animals and submitted to the following treatments, respectively: Maturity 1 (Slaughter Weight-1) - 400 kg LW; Maturity 2 (Slaughter Weight -2) - 450 kg LW; Maturity 3 (Slaughter Weight -3) - 500 kg LW. A "ad libitum" ration was used for all the animals, in that 50% of DM were supplied by roughage. The EBW was determined after each pre-fixed slaughter of the animals through the sum of the total parts of the body. There was no difference among genetic groups, regarding to values of carcass length, back fat thickness and loin eye area, expressed in absolute values and in % EBW. There was no difference among genetic groups (MUR, JAF and MED) regarding to the proportions of muscles and adipose tissue (AT). On the other hand, JAF presented larger ($P < .05$) proportion of bones (B) than MUR and MED. MED animals presented larger ($P < .05$) relationship soft tissue/bone (ST/B) and muscle/bone (M/B), while JAF presented smaller ($P < .05$) ST/B and M/B. There was not difference among the maturities regarding the proportion of muscles and of fat tissues. Animals slaughtered at 500 kg LW presented larger ($P < .05$) relationship ST/B, M/B and AT/B than animals slaughtered at 405 kg LW.

Key Words: Fat, Muscle, Water Buffalo

M64 Chemical composition, meat quality and consumer acceptability in Mexican retail beef. E. J. Delgado¹, M. S. Rubio^{*1}, F. A. Iturbe², R. D. Mendez¹, L. Cassis³, and R. Rosiles¹, ¹Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autonoma de Mexico Circuito Exterior, Cuidad Universitaria, Mexico, ²Facultad de Quimica, Universidad Nacional Autonoma de Mexico Circuito Exterior, Mexico, ³Departamento Tecnologia alimentos, Universidad La Salle Benjamin Franklin 47, Col. Condesa, Del. Cuauhtemoc.

Mexican beef cattle producers claim the largest part of imported beef is of poor quality and represents a hindrance for the development of the Mexican beef industry, which has exhibited a poor growth for the last years. Under these circumstances, it is vital for the Mexican beef industry to establish a benchmark for the composition and quality of retail beef. The purpose of this investigation was to study the quality characteristics of Mexican and imported retail beef samples. Mexican and imported (USDA-Choice and commodity US) strip loin beef steaks (NAMP 180) were randomly selected from 80 supermarkets in Monterrey, Mexico City, and Villahermosa. Meat samples were analyzed for chemical composition, Warner Bratzler shear force (WBSF), instrumental color (L^* -, a^* -, and b^* - values), and consumer acceptability. All sources of Mexican beef and commodity US beef had similar composition ($P > 0.05$), averaging $73.0 \pm 0.2\%$ moisture, $3.0 \pm 0.2\%$ fat, $22.1 \pm 0.1\%$ protein, 11.7 ± 0.4 mg/g total collagen, and $16.2 \pm 0.4\%$ soluble collagen. In comparison, USDA-Choice beef had significantly higher ($P < 0.05$) fat content ($6.3 \pm 0.2\%$), lower ($P < 0.05$) moisture ($69.9 \pm 0.2\%$) and total collagen content (9.7 ± 0.4 mg/g). Mexican beef from Monterrey and USDA-Choice beef were tender and paler (WBSF 3.6 ± 0.1 and 3.1 ± 0.1 kg, respectively; a^* -values 14.3 ± 0.3 and 14.1 ± 0.3 , respectively) than Mexican beef from Mexico City, Villahermosa and commodity US beef (WBSF 4.6 ± 0.1 , 4.7 ± 0.1 , and 4.6 ± 0.1 kg, respectively; a^* - values 17.1 ± 0.3 , 17.1 ± 0.3 , and 16.6 ± 0.2 , respectively). Consumer acceptability for Mexican beef from Monterrey was similar to that of USDA-Choice. Commodity US beef had the lowest overall desirability score. Results indicate Mexican beef has some advantages to compete with imports in the current open market. Even so, there is still considerable scope for improvement in its quality characteristics and uniformity.

Key Words: Beef Quality, Chemical Composition, Consumer Acceptability

M65 Effects of sodium lasalocid and electrolytes on carcass characteristics of young bulls from north-central Mexico, finished with a brewery grain-based ration. F. Winston-Bennett, J. J. J. Chavez*, R. Bañuelos, S. Mendez, C. F. Arechiga, and F. Echavarría, Universidad Autonoma de Zacatecas, Zacatecas, Mexico.

The objective was to determine the effect of feeding brewery grain, sodium lasalocid and electrolytes on carcass characterization (post mortem) of young bulls (Angus, Brahman, Charolais crosses with an average weight of 380 kg) from north-central Mexico ($22^\circ 52'$ northern latitude and 102° western longitude, and 2,153 m above the sea level). Young bulls were exposed to a feeding-adaptation period of 15 d, followed by a 60 d finishing period. Young bulls ($n=20$), were randomly allotted into two treatments groups: 1) RBG, a ration based on Brewery Grain as a control. 2) RBG+LE, a ration based on Brewery Grain containing Lasalocid and Electrolytes. Measurements include: live weight (LW), hot carcass-weight (HCW), cold carcass-weight (CCW), carcass rudiment (CR), empty body-weight (EBW), water-holding capacity (WHC), pH at 45 min, and 24 h post mortem (pH45m & pH24h), electrical conductivity at 45m and 24 h (EC45m and EC24h), cooking losses (CL). Statistical analysis were performed by a complete-randomized design, contrasting means by Tukey test, besides analyses of principal components. Addition of Lasalocid and Electrolytes increased live weight and carcass weight of the bulls (21.2 and 24.3 kg/bull, respectively), as well as mean carcass-rudiment. Whereas, tended to decrease overall pH, EC and CL. In conclusion, Lasalocid and Electrolytes fed in brewery grain-based ration for young bulls improved live weight, carcass weight, carcass rudiments as well as other meat characteristics of quality such as pH, electrical conductivity, water holding capacity and cooking losses.

	CR	pH45m	pH24h	EC45m	EC24h	WHC	CL
RBG	62.17	6.78	5.59	13.4	77.6	35.28	33.27
RBG+LE	64.55	6.76	5.46	0.4	6.6	33.15	30.47

Key Words: Lasalocid, Feedlot Bulls, Brewery Grain

M66 Hanging the beef carcass by the forequarter to improve tenderness of the *Longissimus dorsi*. A. Luchiar-Filho^{*1}, R. P. Macedo², A. S. C. Pereira¹, S. da L. e Silva¹, P. R. Leme¹, and G. F. Feitosa¹, ¹Faculdade de Zootecnia e Engenharia de Alimentos - USP, Pirassununga, SP, Brazil, ²Marfrig Brazilian Beef Via Dr. Shuhei Uetsuka, km 02, Promissão, SP, Brazil.

During four subsequent days 40 Nellore steer carcasses (10/day) were chosen at random in a federally inspected slaughter plant and hanged alternate left and right sides either in the traditional way by the hindquarter (HQ) or by the forequarter (FQ) hung by the carpi radialis muscle. Carcasses had an avg hot carcass wt of 244.1 kg and up to 30 months old. The 24 h pH was not statistically different, 5.69 for HQ and 5.7 for FQ. Carcasses were chilled for 48 h, when samples from the LD at the 12th rib level and the $\langle I \rangle$ Biceps femoris $\langle /I \rangle$ (BF) at the P3 site level were removed, kept under refrigeration ($0-2^\circ\text{C}$) for 5 d and then frozen for future analysis. The temperature of the $\langle I \rangle$ Longissimus dorsi $\langle /I \rangle$ (LD) after 48 h, taken adjacent the 12th rib was not statistically different 1.0°C for HQ and 0.9°C for FQ. Fat thickness measured at the 12th rib level was different ($P < 0.05$), 3.8 mm for HQ and 4.3 mm for FQ. All samples were thawed for 48 h to refrigeration temperature to evaluate tenderness. Warner Bratzler Shear force from the LD was lower ($P < 0.001$) for the FQ (3.53 kg) than for HQ (4.78 kg) and the BF was not statistically different, 3.61 kg HQ and 3.52 kg FQ. Total cooking losses were not statistically different, 19.7% HQ and 18.9% FQ. Hanging the beef carcass by the forequarter caused a significant improvement in tenderness of the LD without any detrimental effect on the BF (sirloin level). Although not evaluated in this work, it was noticed an increase in diameter and a decrease in length in the LD muscle, that could partially explain the thicker fat layer for the FQ treatment. Further work has been done to evaluate the effects of hanging by the forequarter in forequarter muscles as well as other major hindquarter muscles.

Key Words: Beef, Meat Quality, Tenderness

M67 Estimation of percentage of lean meat on rib loin by computer image analysis for carcass cross section of Wagyu cattle. M. Hasegawa*¹, K. Kuchida¹, S. Hidaka¹, H. Houkiyama², T. Sakai², Y. Yamamoto², and Y. Sato², ¹Obihiro University of Agriculture and Veterinary Medicine obihiro-shi Hokkaido 080-8555 Japan, ²Hokkaido Animal Research Center Shintoku-cho Hokkaido 081-0038 Japan.

For the improvement of meat quantity, it is desirable to utilize more detailed data than merely the carcass weight and cutability, which have been measured and recorded at carcass grading. In this study, each muscle area and the ratio of muscle area to total area (MAR) were calculated from the 6-7th cross-section of Wagyu cattle, and the relationship between their image analysis traits and the percentage of lean meat was investigated. Images of 41 cross-sections of Wagyu steers (19-21 mo.) were used for the analysis. Areas calculated by image analysis included 13 muscle areas, such as M.longissimus thoracis (LONG), M.trapezius (TRAP), M.latissimus dorsi (LATIS) etc., total muscle area, subcutaneous and intermuscular fat area, cross-section area and MAR. Weights of lean meat, fat, bone and sinew of the 9-11th rib loin were measured by physical dissection. The relationships among muscle areas, as well as those among the percentage of lean meat, each muscle area and MAR were investigated. The percentage of lean meat was predicted using a multiple regression analysis with 21 covariates associated with 17 image analysis traits and grading records. The ranges for carcass weight, percentage of lean meat and MAR were from 129 to 228 kg (mean; 180.8 kg) from 52.1 to 61.2% (56.3%) and from 49.6 to 67.0% (56.7%), respectively. The correlation coefficient between muscle areas in LONG and TRAP was 0.64 ($p < 0.01$) and 0.73 ($p < 0.01$) in LONG and LATIS. The correlation coefficient between the percentage of lean meat and MAR was 0.53, which was the highest value among the image analysis traits. Selected variables for the prediction equation for estimating the percentage of lean meat were M.ilicostalis area, M.semispinalis capitis area, M.serratus ventralis area, total muscle area and cross-section area. The coefficient of determination (R^2) of the multiple regression equation was 0.69 ($p < 0.01$).

Key Words: Image Analysis, Wagyu, Muscle Area

M68 Development of new photography equipment for carcass cross section of Wagyu beef and its potential use in meat quality evaluation using digital images. K. Kuchida*¹, T. Hori², T. Honma², M. Nami², K. Takahashi¹, M. Hasegawa¹, H. Hokiayama³, T. Sakai³, and Y. Yamamoto³, ¹Obihiro University of Agriculture and Veterinary Medicine Obihiro-shi Hokkaido 080-8555 Japan, ²Hokkaido Industrial Research Institute Sapporo-shi Hokkaido 060-0819 Japan, ³Hokkaido Animal Research Center Shintoku-sho Hokkaido 081-0038 Japan.

In Japan, meat quality grade and yield grade of Wagyu cattle are evaluated by macroscopically observing the cross section of the 6th and 7th rib. Computer image analysis of high resolution for the cross section image may lead to the objective meat quality evaluation. The aims of this study were to develop new photographic equipment for carcass cross section using a digital camera with resolution of 13.5 million pixels, and to investigate the feasibility of this new evaluation method for beef marbling using clear digital images obtained by the equipment. KODAK DSC 14n with a 35mm CMOS device was used as the digital camera with a wide angle lens (Nikkor AF ED 14mm F2.8D). The circumference of light division was shielded so that it would not receive external light. The stainless frame installed on the bottom face of the lighting division was in contact with the carcass surface at photography, so that constant distance and vertical direction could be obtained in the digital image. The height of this equipment was 330 mm, and the photographed image had a range of 300×400mm and included the middle point of *M. latissimus dorsi*. Carcass cross sections of nine Japanese Black steers were photographed. The accuracy of binarization was sufficient for the analysis of meat quality because the source of light was illuminated uniformly on the rib eye area, even when binarization with a single threshold value with the discrimination analysis method was executed. Moreover, a slight fine marbling area of about 0.005cm² (30 pixels) could be clearly and accurately binarized. Means for rib eye area (44.1±6.9 cm²) and marbling percentage (29.5±6.6%) in rib eye obtained from this new equipment were close to those (45.4±7.0 cm², 29.5±5.9%) obtained from the former equipment developed in 1999. No

significant differences were recognized between measurement values from both equipments ($P > 0.05$).

Key Words: Image Analysis, Wagyu, Marbling

M69 Correlations among carcass traits taken by ultrasound and after slaughter in Mediterranean (Bubalus bubalis) bulls fed in feedlot. A. M. Jorge*¹, C. Andrighetto², D. D. Millen³, and M. G. Calixto², ¹UNESP-FMVZ-DPEA-Botucatu, ²UNESP-FMVZ-PGZOO-Botucatu, ³UNESP-FMVZ-DPEA-Botucatu.

The objective of this work was to estimate the correlations among measurements taken in vivo with ultrasound equipment with some carcass traits measured after slaughter. Twenty eight Mediterranean bulls, with average shrunk body weight of 300 kg and 15 months of age, were fed a high concentrate diet for by 120 days. The shrunk body weight, the ribeye area (REAU) and the fat thickness (FTU) over the Longissimus dorsi muscle between 12 and 13th ribs, were measured at 28 days intervals. Real-time ultrasound equipment Piomedical Scanner 200 VET, with 18 cm linear array transducer was utilized. After the slaughter, the hot carcass weight (HCW) and the kidney, pelvic and inguinal fat (KPIF) were weighted and the dressing percentage (DP) calculated. After 24 hours of cooling the ribeye area (REAC) and the fat thickness (FTC) were measured. Both the REAC and the FTC were underestimated by ultrasound measurements. The Pearson correlation coefficients for ribeye area and backfat thickness, measured in the carcass and with ultrasound, were 0.78 and 0.89, respectively. The coefficient between DP and REAU was 0.28; 0.45 between DP and REAC, - 0.28 between DP and FTU and -0.30 between DP and FTC. The KPIF presented a 0.52 correlation coefficient with FTC and FTU. The Spearman correlation was estimated between REAU and REAC and FTU and FTC, and the values were 0.90 and 0.79, respectively.

Key Words: Backfat Thickness, Ultrasound, Water Buffalo

M70 Effect of dietary vitamin E supplementation and storage time on physical characteristics of ten muscles from beef cattle. F. G. Rios*, R. Cortina, G. Contreras, and J. J. Portillo, FMVZ-Universidad Autonoma de Sinaloa, Mexico Carr. Culiacan-Mazatlan km. 3.5.

The objective was to determinate the effect of dietary vitamin E supplementation and storage time on the physical characteristics of ten vacuum packaged beef muscles. A complete randomized block design experiment used eighty Brahman-cross bull calves (28 months of age), assigned to receive one of two treatments during experimental period of 30 d prior to slaughter: 1) Regular finishing diet supplemented with 2000 IU of vitamin E for kg/DM and 2) Regular finishing diet. The animals were slaughtered and carcasses refrigerated for 24 h. Ten, 100g samples were obtained from the following muscles: *longissimus thoracis* (LT); *obliquus abdominis externus* (OAE); *longissimus spinalis* (LE); *pectoralis profundis* (PP); *supraespinatus* (SE); *longissimus lumborum* (LL); *biceps femoris* (BF); *semiteminosus* (ST); *semimembranosus* (SM); and *gluteus medius* (GM). Samples were packed with a Ultravac#8482 machine and refrigerated at 4 C. Muscle sample drip loss (DL), pH and colour ($L^*a^*b^*$) were determined on day 0, 7, 14, 21, and 28. Muscles LT and OAE, showed no effect ($P > 0.05$) by treatments for DL. Muscles LE, GM, and BP, DL was 15.35 % less ($P < 0.01$) at d 14, but showed no difference in others periods of storage. Muscle pH diminished ($P = 0.03$) at 7 to 21 storage time for LT, LE, OAE, SM, SE, GM, and PP, with a mean of 5.71 in the muscles from the vitamin E treatment. Brightness (L^*) was modified by vitamin E supplementation in LT (44.35 vs. 40.64) at 21 d, ST (39.19 vs. 37.64) at 7 d, and GM (39.18 vs. 37.60) at 14 d. Redness (a^*) was modified by vitamin E supplementation in SE (20 vs 10.74), PP (15 vs. 11.69), GM (20.9 vs. 10.74) at 28 d storage, and BP (20.9 vs. 10.28) at 7 d storage. It is concluded that 2000 IU/ kg DM vitamin E supplementation improve the physical characteristics of fresh, vacuum packaged bovine meat.

Key Words: Vitamin E, Bovine Meat, Vacuum Packed

M71 Tenderness improvement in fresh and frozen/thawed beef strip loins treated with hydrodynamic pressure processing. M. B. Solomon*, M. Liu, J. Patel, E. Paroczay, and J. Eastridge, *USDA, ARS, FTSL*.

The effect of hydrodynamic pressure processing (HDP) using two different shaped charges (rectangular [REC] vs cylindrical [CYL]) and meat state at 48 h postmortem of beef strip loins (N=16) on meat tenderness was evaluated. HDP was performed by detonating 100 g of explosive placed above vacuum packaged meat samples immersed in water in plastic containers. Meat state was fresh, never frozen compared to frozen at 48 h postmortem followed by thawing at 6-d postmortem. Meat samples were evaluated for tenderness by shear force measurements at both d-1 and d-6 after being treated with HDP. Both shapes of explosives improved ($P < 0.01$) shear force on d-1 (CYL 4.6 vs 5.4 kg; REC 4.4 vs 5.4 kg) compared to controls. The effect of HDP was sustained ($P < 0.01$) throughout d-6 of aging, with the CYL reaching 3.9 kg and the REC reaching 3.6 kg compared to controls (4.5 kg). Freeze/thaw samples were 1 kg lower at d-1 compared to fresh samples (4.3 vs 5.3 kg) and 0.9 kg lower at d-6 (3.6 vs 4.4 kg). There were no significant interactions for meat state and HDP treatments. The percentage of samples with HDP improvements $> 10\%$ was higher for the REC shaped explosive (81%) compared to the CYL shape (56%). Furthermore, the percentage of samples with HDP improvements $> 10\%$ was higher for fresh meat samples (71%) compared to frozen/thawed samples (66%). The percentage of samples that improved greater than the aged control was 100% for REC, 87% for CYL, 94% for fresh samples, and 81% for frozen/thawed samples. These results suggest that both HDP and early postmortem freezing followed by thawing are successful treatments for improving meat tenderness and are better than extended aging for non-treated controls.

Key Words: Tenderness, Pressure Processing, Aging

M72 Recombinant hepatocyte growth factor (rHGF) over-expressed by C2C12 myoblasts is biologically active. C. Zeng*¹, D. E. Gerrard¹, K. H. Hannon², and A. L. Grant¹, ¹*Department of Animal Sciences, Purdue University, West Lafayette, IN*, ²*Department of Basic Medical Sciences, Purdue University, West Lafayette, IN*.

Hepatocyte growth factor (HGF) is a growth factor that activates quiescent satellite cells and alters their growth in culture and in skeletal muscle. In an attempt to increase the amount of local HGF in skeletal muscle, we generated an expression construct to produce an epitope-tagged HGF (rHGF) protein. Reverse transcription-polymerase chain reaction (RT-PCR) was used to clone a cDNA encoding full-length HGF from mouse liver total RNA (forward primer: ATGATGTGGGGGACCAAACCT, reverse primer: TTACAACCTGTATGTCAAAA). The cDNA was subcloned into the pcDNA3.1/V5-His-TOPO expression vector and used to transfect C2C12 myoblasts. Immunoblots containing the concentrated conditioned media from myoblasts stably expressing rHGF showed that the expressed rHGF could be detected using antibodies against HGF or the V5 epitope. Monoclonal anti-HGF antibody detected the N-terminal 70 kDa α -chain of rHGF, whereas the anti-V5 antibody detected the C-terminal 40 kDa β -chain in which the V5 epitope was located. Moreover, subjecting conditioned media to a His-column removed the majority of immunoreactive protein, further suggesting that the product was recombinant HGF-V5-His protein. Furthermore, the conditioned media stimulated C2C12 myoblast replication similar to a commercially available HGF. In experiments in which one-half of DMEM was replaced with FBS-free conditioned medium from stably transfected C2C12 myoblasts, the proliferative effect on normal C2C12 myoblasts was the same ($P > .05$) as that observed when normal C2C12 myoblasts were cultured in DMEM containing a commercial HGF at 5 ng/ml. Finally, immunoneutralization of conditioned media using an anti-HGF antibody at the concentration of 1 $\mu\text{g/ml}$ eliminated ($P < .05$) this proliferative effect in culture, suggesting that rHGF is the major component in conditioned medium to exert the proliferative action. We conclude that our recombinant epitope-tagged HGF is biologically active when expressed in C2C12 myoblasts. This construct provides a valuable reagent for investigating the role of HGF in controlling satellite cell-mediated muscle growth.

Key Words: Hepatocyte Growth Factor (HGF), Muscle, Satellite Cell

M73 Correlations and prediction equations for fatty acids and sensory characteristics of beef longissimus rib steaks from three forage rations and commercial USDA Choice and Select rib steaks. R. T. Baublits*¹, F. W. Pohlman¹, A. H. Brown, Jr.¹, Z. B. Johnson¹, D. C. Rule², C. M. Murrieta², D. O. Onks³, B. A. Sandelin¹, H. D. Loveday³, C. J. Richards³, and R. B. Pugh³, ¹*University of Arkansas, Fayetteville*, ²*University of Wyoming, Laramie*, ³*University of Tennessee, Knoxville*.

Rib steaks (n = 52) from cattle grazing fescue, fescue with soyhull supplementation, orchardgrass with soyhull supplementation, and USDA Choice and Select rib steaks obtained from area purveyors were utilized to determine fatty acid profiles and sensory characteristics. Correlations between fatty acids and sensory characteristics were performed. Also, utilizing fatty acid values, prediction models for sensory characteristics were developed. The beef/brothy and beef fat sensory characteristics were positively correlated ($P < 0.05$) with 16:0, 16:1cis-9, and 18:1, and negatively correlated ($P < 0.05$) with 15:0, α -18:3, 20:4, 20:5, 22:5, and 22:6. The grassy sensory characteristic was positively correlated ($P < 0.05$) with 15:0, 16:1trans-9, 18:0, 18:2cis-9,trans-11 (CLA), α -18:3, 20:5, 22:5, and 22:6. Regression utilizing stepwise selection to develop prediction equations for sensory characteristics was performed, and the beef/brothy sensory characteristic was best predicted ($P < 0.05$) by the single fatty acid 20:5, with this fatty acid explaining 40 % of the variation in beef/brothy flavor. Conjugated linoleic acid (CLA) and α -18:3 were utilized in the model that best predicted ($P < 0.05$) milky/oily flavor, with these two fatty acids explaining 31 % of the variation. These results indicate that CLA and the 20- and 22-carbon polyunsaturates have large roles in influencing flavor, causing increases in grassy and milky/oily flavor or decreasing beef/brothy flavor.

Key Words: Fatty Acid, Sensory, Correlation

M74 Characterization of Romosinuano breeding on palatability traits and retail shelf life of beef steaks. W. J. Horne*¹, J. C. Brooks¹, S. W. Coleman², W. A. Phillips³, D. G. Riley², C. C. Chase Jr.², and M. F. Miller¹, ¹*Department of Animal and Food Sciences, Texas Tech University, Lubbock*, ²*USDA, ARS, SubTropical Agricultural Research Station, Brooksville, FL*, ³*USDA, ARS, Grazinglands Research Laboratory, El Reno, OK*.

This study was conducted to evaluate if Romosinuano (R) cattle, a *Bos taurus* breed native to Columbia, would differ from Brahman (B) and Angus (A) cattle in palatability and retail shelf life properties of beef steaks. Steers (n=142) representing a three-breed diallel crossbreeding program (AA, BB, RR and crossbreds: AB, AR, BA, BR, RA, RB; first letter indicates breed of sire and second letter indicates breed of dam) were fed in El Reno, OK. Carcass data was collected at 48 h post harvest. Loins were recovered, aged for 7 d and fabricated into 2.54 cm-thick steaks for use in Warner-Bratzler shear (WBS), slice shear, and sensory analysis. WBS results indicate that BB cattle exhibited the highest ($P < 0.05$) values (3.98 kg \pm 0.16) while AA and RA had the lowest (3.16 kg \pm 0.20). RA cattle had WBS values similar to the RB cattle, while AR had lower ($P < 0.05$) WBS values than BR. Slice shear results indicate that BB cattle had the highest ($P < 0.05$) values (15.58 kg \pm 0.87) while AB had the lowest (11.93 kg \pm 0.82). RA and AR cattle had similar slice shear values to RB and BR cattle. When R was used on the maternal side of the cross, steers exhibited higher Warner-Bratzler shear values and less desirable sensory panel tenderness scores ($P < 0.05$) than steers sired by R bulls. Breed did not have a significant effect on retail display properties. Results indicate that palatability and shear force values were improved when R was represented on the paternal, rather than maternal, side of the cross. Finally, RA and AR cattle produced panel tenderness scores, shear force values, and retail display properties similar to the BA and AB cattle.

Key Words: Romosinuano, Shelf Life, Palatability

M75 Comparison of beef tallow versus poultry fat in the finishing diets of steers on muscle and subcutaneous fatty acid profiles. S. Hutchison^{*1}, E. B. Kegley¹, J. K. Apple¹, T. J. Wistuba², and D. C. Rule³, ¹University of Arkansas, Fayetteville, ²Morehead State University, Morehead, KY, ³University of Wyoming, Laramie.

Poultry fat has become a more economical source of energy than by-products currently used. Therefore, this study was conducted to determine the effects of dietary fat source (poultry fat or beef tallow) in finishing diets for cattle on the fatty acid composition of beef. Sixty Angus crossbred steers (410.8 kg initial BW) were stratified by source, blocked by weight, and assigned within block to 15 pens (4 steers/pen). Pens were then assigned randomly within blocks to one of three dietary treatments consisting of: 1) a corn-soybean meal control diet devoid of supplemental fat (Ctrl); 2) the control diet formulated with 4% tallow (TAL); or 3) the control diet formulated with 4% poultry fat (PF). Cattle were fed for 112-d and harvested at a commercial beef packing plant. Wholesale ribs were collected during carcass fabrication (357.7, 357.3, and 369.5 kg for carcasses of Ctrl, TAL, and PF-fed cattle, respectively), and samples of subcutaneous fat and LM were analyzed for fatty acid composition (reported as mg/g wet tissue). In the LM, total saturated fats (14:0, 15:0, 16:0, and 18:0) were similar ($P > 0.10$) among diets. Furthermore, total monounsaturated fatty acids (MUFA) were not ($P > 0.10$) affected by finishing diets. The LM from the steers fed PF had increased ($P < 0.05$) 18:2 and total PUFA than the LM of the steers fed Ctrl or TAL-diets. Conversely, the LM of TAL-steers had lower ($P < 0.05$) concentrations of 20:3 than Ctrl or PF-fed steers. The only changes detected in subcutaneous fat were steers that consumed the Ctrl-diet had the highest ($P < 0.05$), and PF-fed steers had the lowest ($P < 0.05$), 17:0 concentrations. Furthermore, subcutaneous fat from TAL-fed steers had lower ($P < 0.05$) conjugated linoleic acid concentrations than fat from controls and PF steers; however, diet did not ($P > 0.10$) affect total saturated, MUFA, PUFA, omega-6, or trans fatty acids. Feeding finishing steers diets formulated with poultry fat did not negatively impact the fatty acid composition of subcutaneous fat or the LM, and may serve as an alternative to beef tallow as a source of energy for cattle finishing diets.

Key Words: Beef Tallow, Poultry Fat, Fatty Acids

M76 Comparison of beef tallow versus poultry fat in the finishing diets of steers on beef quality during retail display. S. Hutchison^{*1}, J. K. Apple¹, E. B. Kegley¹, and T. J. Wistuba², ¹University of Arkansas, Fayetteville, ²Morehead State University, Morehead, KY.

The current study was conducted to determine the effects of dietary fat source (poultry fat or beef tallow) in finishing diets of cattle on beef quality traits during 7 d of simulated retail display. Sixty Angus crossbred steers (410.8 kg initial BW) were stratified by fat source, blocked by weight, and assigned to 15 pens (4 steers/pen). Pens were then assigned randomly within blocks to one of three dietary treatments consisting of: 1) a corn-soybean meal control diet devoid of supplemental fat (Ctrl); 2) the control diet formulated with 4% tallow (TAL); or 3) the control diet formulated with 4% poultry fat (PF). Cattle were fed for 112-d and harvested at a commercial beef packing plant. Wholesale, bone-in ribs were collected during carcass fabrication, and 2.54-cm thick, boneless LM steaks were cut, weighed, placed on foam trays with an absorbent pad, and overwrapped with PVC film for display (deluxe warm white

Nonruminant Nutrition: Weanling Pig - Vitamin & Mineral

M78 Is vitamin B6 a modulator of the effect of supplementary tryptophan on tryptophan metabolism and growth responses in weanling pigs? J. J. Matte^{*1}, N. LeFloc'h², C. Relandeu³, L. Le Bellego³, A. Giguère¹, and M. Lessard¹, ¹Agriculture and Agri-Food Canada, Lennoxville, Qc, Canada, ²Institut National de la Recherche Agronomique, St-Gilles, France, ³Ajinomoto Eurolysine S.A.S., Paris, France.

The present experiment aimed to determine if tryptophan (Trp) metabolism and the eventual growth response to dietary supplement of Trp is modulated by the dietary supply of pyridoxine (B6). Early-weaned piglets ($n = 544$) (BW: 5.96 ± 0.14 kg) were grouped in 32 pens ($n = 32$) of 17 animals and distributed by initial weight ranges in four

light; 1600 lx) in chest-type display cases (3°C). On d 0, 1, 3, 5, and 7 of display, a three-person panel scored steak discoloration (1 = total discoloration to 7 = no discoloration), and instrumental color (L^* , a^* , and b^* values) was measured and used to calculate hue angle, chroma, and delta E (measure of total color change from d-0) values. Thiobarbituric acid reactive substances (TBARS) of steaks were measured on d 0 and 7 of display. Beef became lighter (higher L^* value; $P < 0.01$), and less red (lower a^* value; $P < 0.001$) and yellow (lower b^* value; $P < 0.001$) during the 7 d of retail display. The LM from Ctrl-steers tended to be lighter (higher L^* value; $P < 0.10$); however, there were no ($P > 0.10$) diet effects on a^* , b^* , hue angle, chroma, delta E, or discoloration scores. Even though TBARS concentrations were numerically higher in the LM of steers consuming diets formulated with fat (0.54, 0.53, and 0.34 mg/kg for PF, TAL, and Ctrl, respectively), diet had no ($P > 0.10$) appreciable effect on the development of oxidative rancidity. Results indicated that replacing beef tallow with a more economical energy source, poultry fat, in cattle finishing diets had no detrimental effects on beef quality during retail display.

Key Words: Dietary Fat, Beef Quality, Retail Display

M77 Glycolytic intermediates in muscle and adipose tissue of cattle fed different sources and amount of energy. R. D. Rhoades^{*}, J. T. Vasconcelos, D. K. Lunt, J. E. Sawyer, K. Y. Chung, and S. B. Smith, Department of Animal Science, Texas A&M University, College Station.

Seven Angus and eight Wagyu steers (BW = 208 and 172 kg) were used to evaluate energy source effects on glycolytic intermediates within muscle and adipose tissue. Steers were blocked by breed and fed a corn-based diet for 244 d (total energy: 3207 Mcal/kg) or a hay diet for 362 d (total energy: 6293 Mcal/kg). Corn-based diet was fed for 1.3 kg/d gain. Hay-fed steers were fed to the same carcass endpoint. Carcass adjusted fat thickness (AFT), marbling score, postmortem plasma, muscle, subcutaneous, and intramuscular adipose tissues were collected. Data were analyzed as a complete block design. Plasma glucose ($\mu\text{mol/ml}$) was numerically greater ($P=0.06$) in corn-fed (3.77 ± 0.06) vs. hay-fed (2.88 ± 0.05) steers. Glucose ($\mu\text{mol/g}$) in muscle was greater ($P=0.04$) in hay-fed steers (4.68 ± 0.07 vs. 3.07 ± 0.08). Muscle glucose-6-phosphate (G6P), and fructose-6-phosphate (F6P; $\mu\text{mol/g}$) were similar ($P=0.10$) among treatments. Glucose ($P=0.13$), G6P ($P=0.34$), and F6P ($P=0.22$) concentrations in subcutaneous adipose were also similar. Glucose and F6P concentrations in intramuscular adipose were 2-fold and 10-fold higher, respectively, than observed in subcutaneous depots, but were similar ($P>0.6$) for corn-fed and hay-fed steers. G6P was numerically greater in hay-fed (0.186 ± 0.008) vs. corn-fed steers (0.084 ± 0.009 ; $P=0.08$). Steers were fed to a common AFT (0.47 cm). Mean marbling score in corn-fed steers (710 ± 78) was numerically greater than in hay-fed steers (564 ± 72) although statistical separation was not achieved ($P=0.4$). Plasma glucose indicates greater glucose pool size in corn-fed steers; greater concentrations of glucose and intermediaries in muscle of hay-fed steers may reflect decreased pathway flux. Correlations between marbling score and intramuscular adipose glucose concentration were -0.6 ($P=0.18$) for corn-fed steers and 0.7 ($P=0.04$) for hay-fed steers, supporting the concept that corn-based diets promoted provision and utilization of glucose for accretion of intramuscular fat relative to hay-based diets. Manipulation of glucose disposal rate in finishing steers may improve carcass quality grade.

Key Words: Glucose, Marbling, Energy

factorial treatments ($n = 8$ pens in each): two dietary additions of B6 [0 (B6-) vs. 5 ppm (B6+)] and two dietary additions of synthetic Trp [0 (Trp-) vs. 0.05 % (Trp+) for a Trp/Lys ratio of 0.174 vs. 0.204, respectively]. Growth performance was recorded every week from 2 to 9 wk of age. Blood samples were taken from 64 piglets, two from each pen, before initiation of treatments and at 4, 6 and 8 wk of age. No treatment effect ($P > 0.19$) was observed on overall ADFI (679 ± 7 g), ADG (454 ± 4 g), or feed conversion (1.50 ± 0.01), although the B6+Trp+ piglets had the highest ADG and feed conversion during the last week of experiment (B6 x Trp x Age linear, $P < 0.02$). Pyridoxal in red blood cells was 19% lower in B6- ($2.8 \pm 0.1 \mu\text{M}$) than in B6+ piglets ($3.3 \pm 0.1 \mu\text{M}$; B6 x Age quadratic, $P < 0.01$). Initial values

($33.1 \pm 1.5 \mu\text{M}$) of plasma Trp declined ($P < 0.01$) with age but the effect tended to be more pronounced (B6 x Age linear, $P < 0.08$) in B6 than in B6+ piglets; values at 8 wk of age were 22.6 ± 1.7 vs $26.7 \pm 1.4 \mu\text{M}$, respectively. Initial values ($1.48 \pm 0.09 \mu\text{M}$) of plasma kynurenin, an intermediate metabolite of Trp oxidation, decreased with age but were higher, at 4 and 6 wk of age, in Trp+ than in Trp- piglets (Trp x Age quadratic, $P < 0.01$); this effect faded ($1.21 \pm 0.07 \mu\text{M}$) at 8 wk of age. It seems that, although stimulated by dietary Trp at 4 and 6 wk of age, Trp oxidation would not be altered at 8 wk of age in spite of the B6 x Trp effect. This apparent sparing effect of B6 on Trp status could originate from the small intestine microflora since bacterial synthesis of Trp is B6-dependent. Those late (8 wk of age) metabolic and growth performance effects merit further investigation especially for their eventual carry over impact shortly after the nursery period.

Key Words: Tryptophan, Pyridoxine, Piglets

M79 Vitamin C and β -carotene in weanling pig diets. D. M. Fernandez^{*1} and J. A. Cuaron², ¹Universidad Nacional Autonoma de Mexico Mexico City, ²Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias Queretaro, MX.

Two experiments were conducted to evaluate productive performance of lightweight pigs at weaning in response to vitamin C and β -carotene supplementation at 150 and 350 mg/kg of diet, respectively, on both a commercial farm (Trial 1) and an experimental farm (Trial 2). Supplementary energy source used in each experiment was oxidized canola oil in Trial 1 and oxidized tallow in Trial 2. In Trial 1, piglets were weaned at 22.08 ± 1.66 days of age and 5.47 ± 1.18 kg. In Trial 2 animals were weaned at 21.5 ± 0.85 days of age, weighing 5.79 ± 1.12 kg. Vitamins were added from a corrected standard commercial premix. Both trials were conducted as a randomized complete block design in a factorial arrangement (2 vitamin C 2 β -carotene levels) and the treatments were: 1) Vitamin C, 0 and β -carotene, 0 mg/kg of diet (T1); 2) Vitamin C, 150 and β -carotene, 0 mg/kg (T2); 3) Vitamin C, 0 and β -carotene, 350 mg/kg of diet (T3); 4) Vitamin C, 150 and β -carotene 350 mg/kg (T4). In Trial 1, there were no differences ($P > .13$) in ADFI, ADG and feed efficiency (FE). In Trial 2, after 20-d, a Vitamin C by β -carotene interaction in ADFI was observed ($P < .03$). ADFI was greater for T1 and T4 compared to T2 and T3 (.292 and .287 vs .251 and .259). The ADG and FE were not affected. It is concluded that antioxidant capacity of the diet provided by standard levels of Vitamin E, Se and chemical antioxidants (BHT) is sufficient to overcome oxidative stress imposed on lightweight pigs at weaning.

Key Words: Weanling Pigs, Vitamin C, Beta-Carotene

M80 Ontogeny of mitochondrial carnitine palmitoyltransferase I in porcine liver and skeletal muscle. P. Lyvers Pepper^{*1}, X. Lin¹, L. Averette Gatlin¹, J. Woodworth², and J. Odle¹, ¹North Carolina State University, Raleigh, ²Lonza, Inc., Fairlawn, NJ.

Molecular evaluation of carnitine status can be made by comparing tissue carnitine concentrations with the carnitine- K_M of carnitine palmitoyltransferase I (CPT I). Therefore, a study was conducted to assess hepatic and muscle mitochondrial CPT I kinetics in pigs during different stages of development. Mitochondria were isolated from liver and semitendinosus muscle from suckling, 24-h-old and fed 5-wk-old (2 wk post-weaning) pigs. Activity of CPT I was determined via radioenzymatic analysis, and the V_{max} and apparent K_M for carnitine were estimated. Activity (V_{max}) in skeletal muscle increased between 24 h and 5 wk of age, signifying developmental induction, but no change in V_{max} was detected in hepatic tissue. Despite increased CPT I activity of skeletal muscle, differences in the K_M for carnitine were not detected for either tissue examined. The ontogenic induction of skeletal muscle CPT I may be necessitated by contracting muscle preferentially oxidizing fatty acids as their primary fuel.

Carnitine palmitoyltransferase I kinetic constants (V_{max} and apparent K_M) measured in mitochondria from hepatic and muscle tissue of pigs¹

	AGE	
	24 h (n = 5)	5 wk (n = 4)
V_{max} , $\mu\text{mol}/(\text{hg mitochondrial protein})$		
Liver	25.1 ± 4.4	30.3 ± 4.9
Skeletal Muscle ^a	25.8 ± 4.0	44.9 ± 4.5
K_M for carnitine, $\mu\text{mol}/\text{L}$		
Liver	254 ± 36	301 ± 40
Skeletal Muscle	350 ± 80	495 ± 90

¹Values are means \pm SE; ^aAge effect, $P < 0.05$.

Key Words: Carnitine Palmitoyltransferase, Ontogeny, Pigs

M81 Determination of true digestible calcium and phosphorus requirements in weaned pigs. M. Fan^{*1}, Y. Shen¹, T. Archbold¹, A. Holt¹, and Y. Yin², ¹University of Guelph, Guelph, Ontario, Canada, ²The Chinese Academy of Sciences, China.

This study was conducted to determine true digestible calcium (Ca) and phosphorus (P) requirements in weaned pigs. Thirty-six Yorkshire pigs (18 barrows and 18 gilts), initial and final BW of 10 and 18 kg, were fed six experimental diets for six periods according to a completely randomized block design. The six diets were corn and soybean meal-based, and formulated to contain six levels of total Ca at 0.49, 0.58, 0.67, 0.74, 0.83, and 0.92%, and total P at 0.42, 0.50, 0.58, 0.64, 0.72, and 0.80%, respectively, through supplementing limestone and dicalcium phosphate. Diet 1 was the control diet and contained 0.49% total Ca and 0.42% total P corresponding to 0.40% true digestible Ca and 0.21% true digestible P without supplemental P but with limestone supplementation. Each experimental period lasted 25 d with 20-d adaptation and 4-d collection of total urine excretion and fecal samples. BW gain and feed intake were recorded. Graded levels of Ca and P did not affect ($P > 0.05$) feed intake, weight gain, and feed conversion. Supplementation of P did not improve ($P > 0.05$) P retention, whereas Ca supplementation increased ($P < 0.05$) Ca retention. Diet 1, with total Ca and P contents below the NRC (1998) recommendations, was associated with the minimal levels of total manure Ca and P excretion. In conclusion, the current NRC (1998) recommendations of Ca and P requirements for weaned pigs are likely overestimated, therefore resulting in excessive manure Ca and P excretion.

Key Words: Calcium and Phosphorus, Requirements, Weaned Pigs

M82 Diet buffer capacity and mineral sources alter growth and Salmonella prevalence in nursery pigs. P. Bahson, M. E. Glenn, and T. D. Crenshaw^{*}, University of Wisconsin, Madison.

Diet buffer capacity and organic acids are potential substitutes for sub-therapeutic antibiotics in nursery pigs. Coliforms and clostridia, but not lactobacillus, were reduced in ingesta from nursery pigs fed diets with low buffering capacity (LB) vs. high buffering capacity (HB), organic acids, or antibiotics. The LB diets involved shifts in sources and levels of minerals, but LB and HB diets were based on plant protein (Pln) ingredients. Whether shifts in microflora were related to minerals or Pln ingredients was not distinguished. This trial involved pigs fed complex diets (Cmx) which included whey, lactose, porcine plasma protein and blood cells, or Pln diets used earlier. Diets included: 1) Cmx + carbadox, 2) Cmx + citric acid, 3) Cmx + HB, 4) Cmx + LB, 5) Pln + HB, 6) Pln + LB. No antibiotics were added to diets 2-6. In LB diets sources (tricalcium phosphate and calcium sulfate) and levels (0.80 % Ca and 0.80 % P, diets 1, 3, and 5; 0.55 % Ca and 0.65 % P, diets 2, 4, and 6) were altered. Ninety-six pigs (PIC Cambrough X Line 19) were weaned (3 wk) and randomly allotted to diets for 31 d (P1, 14 d; P2, 17 d). In P1, pigs fed Cmx + carbadox and Cmx + LB gained faster ($P < 0.01$) than those fed other diets over both P1 and P2. Pigs fed Pln diets gained less ($P < 0.01$) than pigs fed Cmx diets during P1, but not P2, or the entire 31 d. On d 0, 41% of pigs were Salmonella positive. Pigs fed the Cmx + LB diet had the highest prevalence on d 7, but prevalence was also higher on d 0 ($P < 0.01$). Salmonella prevalence apparently did not compromise growth. Feeding LB diets improved growth to levels equal to pigs fed carbadox.

Trait	Period	Cmx		Pln				SEM
		+ Carbadox	+ Citric acid	+ HB	+ LB	+ HB	+ LB	
Gain, kg/d								
	0-14 ^{abc}	0.098	0.073	0.062	0.117	0.048	0.016	0.011
	14-31 ^{ab}	0.443	0.394	0.353	0.426	0.402	0.384	0.023
	0-31 ^{ab}	0.288	0.249	0.222	0.287	0.242	0.218	0.017
Salmonella prevalence,								
	0 ^b	38	31	31	69	25	50	12
	4	44	50	56	63	50	69	14
	7 ^b	25	44	31	75	50	31	12
	31	19	31	19	31	25	0	11

^aDifference + Carbadox vs. others ($P < 0.05$);

^bCmx + HB vs. Cmx + LB differs ($P < 0.05$);

^cCmx + HB, + LB differs from Pln + HB, + LB ($P < 0.05$).

Key Words: Antibiotics, Minerals, Salmonella

M83 Effect of supplementing zinc oxide and biotin with or without carbadox on nursery pig growth performance. H.D. Wilt* and M.S. Carlson, *University of Missouri, Columbia*.

A 28-d nursery experiment was conducted to evaluate the effects of supplementing zinc oxide (ZnO) and biotin with or without a feed-grade antibiotic (carbadox) on nursery pig performance, as well as plasma and fecal Zn concentrations. One hundred ninety-two crossbred pigs (5.94 ± 0.03 kg; 20 d of age) were weaned and allotted to one of eight treatments based on weight, sex, and ancestry in a randomized complete block design (3 pigs/pen and 8 reps). Phase 1 (d 1 to 14) and Phase 2 (d 15 to 28) nursery diets were fed in meal form. Fecal samples were collected weekly and pigs were bled on d 1, 14, and 28 to measure Zn concentrations. Phase 1 and Phase 2 diets utilized 8 dietary treatments in a 2 × 2 × 2 factorial design: (1) Basal diet contained 135 ppm Zn as ZnSO₄ and no supplemental d-biotin, (2) Basal + 25 g/T carbadox, (3) Basal + 3,000 ppm Zn as ZnO, (4) Basal + 3,000 ppm Zn as ZnO + 25 g/T carbadox, (5) Basal + 440 ppb biotin, (6) Basal + 440 ppb biotin + 25 g/T carbadox, (7) Basal + 3,000 ppm Zn as ZnO + 440 ppb biotin, and (8) Basal + 3,000 ppm Zn as ZnO + 440 ppb biotin + 25 g/T carbadox. Dietary treatments had no effect ($P > 0.05$) on growth performance during wk 1 or Phase 2. During wk 2, Phase 1 and overall, pigs fed either 3,000 ppm Zn as ZnO or 440 ppb biotin independently or in combination with or without carbadox had greater ADG ($P < 0.05$) than the pigs fed the basal diet. However, the greatest overall ADG ($P < 0.05$) was observed in pigs fed 440 ppb biotin with or without ZnO and carbadox. During wk 3 and Phase 2, pigs fed 440 ppb biotin with or without ZnO and carbadox had greater ADFI ($P < 0.05$) than the pigs fed the basal diet. Overall, Gain/Feed improved ($P < 0.05$) when pigs fed either the 3,000 ppm Zn as ZnO or 440 ppb biotin independently or in combination with carbadox. Plasma and fecal Zn concentrations were higher ($P < 0.05$) for pigs fed the 3,000 ppm Zn as ZnO compared to pigs fed the other dietary treatments. These results indicate that feeding nursery pigs either 440 ppb biotin or 3,000 ppm Zn as ZnO improve growth performance with or without carbadox.

Key Words: Biotin, Nursery pigs, Zinc

M84 Impact of feeding herbal extracts and additional copper plus zinc on growth performance and immune function of newly weaned piglets. H. Namkung* and C. F. M. de Lange, *Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario, Canada*.

The effect of feeding herbal extracts or additional copper plus zinc to newly weaned piglets on growth performance, gut morphology, and immune system stimulation were investigated. One hundred eighty piglets

(16-19 days of age) were randomly assigned to one of five treatments: non-medicated control (CO), medicated (44 ppm Lincomycin; CO+), herbal extract product (essential oils and spice extracts; Phodé, Albi, France) at diet levels of 0.3 and 0.15% (HEh) or 0.2 and 0.1% (HEl) for phase I and II, respectively, and 160 and 150 ppm of additional copper plus zinc (from copper sulfate and zinc oxide; Cu/Zn). Phase I diets (20.5% CP) were fed for the first three weeks post-weaning and Phase II diets (19.6% CP) thereafter. During phase II, weight gain was highest ($P < 0.01$) for pigs on Cu/Zn, lowest ($P < 0.01$) for CO and intermediate for the other treatments. Over the 7-wk period, there were no differences ($P > 0.01$) in weight gain among pigs on HEh, HEl and CO+ (442, 418 and 431 g/d, respectively), while it was highest for Cu/Zn (481 g/d) and lowest for CO (351 g/d; SEM, 18). Gain:feed and fecal consistency scores were not different among treatments ($P > 0.05$). There were no differences ($P > 0.05$) in morphology of intestine of pigs among treatment, although full and empty weights of total gut, small intestine, and cecum were numerically lower in the pigs on HEh and Cu/Zn and the numbers of goblet cells tended to be increased in villi and decreased in crypt in intestines of pigs fed HEh and HEl. Counts of white blood cells and neutrophils were higher ($P < 0.01$) in pigs on d 14 than on d 7 post-weaning. Lymphocyte count was lower ($P < 0.05$) in pigs on HEl compared to other treatments. Plasma concentrations of IgG on d 14 tended to be lower ($P < 0.10$) in pigs on HEl, HEh, Cu/Zn, CO+ than on CO. These results suggest that the herbal extract product could be used as an alternative to in-feed antibiotics.

Key Words: Piglets, Herbal Extract, Growth Promotion

M85 The role of high dietary zinc oxide in cholecystokinin and insulin-like growth factor I secretion and growth in weaned pigs. D. Li* and J. Yin, *Ministry of Agriculture Feed Industry Center, China Agricultural University, Yuanminyuan, Beijing*.

In this study, the mechanism through which high levels of dietary zinc oxide (ZnO) stimulate pig growth was investigated. Thirty-six, 28-d old weaned male pigs (initial BW, 7.5 ± 0.5 kg) were randomly assigned to one of two treatments, with 6 pens per treatment and 3 pigs per pen for the 4-wk experiment. The pigs were fed a corn-soybean meal basal diet (20% CP) either supplemented or unsupplemented with 2,000 mg/kg zinc as ZnO. Blood samples (n = 10/treatment) were collected from anterior vena cava, and RNA samples (n = 6) were extracted from the duodenum and the liver. Real time fluorescence quantitative PCR was used to evaluate hormone gene expression of cholecystokinin (CCK), growth hormone receptor (GHR) mRNA, and insulin-like growth factor I (IGF-1) at the transcription level. The results indicated that ADG was improved by zinc supplementation from 0-2 wk ($P < 0.02$) and 0-4 wk ($P < 0.03$) with an improvement in feed conversion from 0-2 wk ($P < 0.01$). Dietary supplementation of ZnO increased the levels of plasma CCK (5.11 vs 3.07 pmol/L, $P < 0.01$) and serum IGF-1 (386.11 vs 227.42 ng/ml; $P < 0.03$). No changes were detected in other gut-brain peptide concentrations including insulin, gastrin, somatostatin (SS) or growth hormone (GH). In the duodenum, the abundance of CCK mRNA and pregastrin mRNA were 2.54 times ($P < 0.01$) and 1.97 times ($P < 0.01$) greater in pigs receiving the diet containing ZnO. In the liver, levels of IGF-1 mRNA and GHR mRNA were increased [4.74 vs 0.23 ($P < 0.001$) and 16.02 vs 6.28 ($P < 0.02$), respectively] by ZnO supplementation. No differences in the level of duodenum IGF-1 mRNA were detected ($P > 0.10$). In conclusion, results indicate that supplementation of pharmacological level of zinc oxide used in this study may enhance plasma CCK content at the level of mRNA transcription, and further upregulate the liver GHR mRNA and IGF-1 mRNA abundance and raise plasma IGF-1 levels. This may help explain the mechanism through which piglet growth is stimulated by zinc oxide.

Key Words: Pig, Zinc Oxide, Gene Expression

Nonruminant Nutrition: Weanling Pig - Energy & Protein

M86 The interaction between cereal source and lactose level on piglet growth performance post weaning. J. M. O'Connell*, J. J. Callan, and J. V. O' Doherty, *Department of Animal Science and Production, University College, Dublin, Ireland.*

Both barley and wheat contain anti-nutritive factors such as β -glucans and xylans, respectively. However, β -glucans have been shown to promote lactic acid bacteria in the large intestine and this would be very beneficial in the absence of in-feed antimicrobial growth promoter. A 2 x 2 factorial was used to investigate the interaction between cereal type (wheat vs. barley) and lactose inclusion (108 vs. 216 g/kg) on piglet performance post weaning. Two hundred weaned piglets (24 d of age; 6.0 kg weight) were blocked on the basis of weight and were assigned to one of four treatments. The treatments were as follows: (1) 150 g/kg lactofeed 70 (LF70); 840 g whey permeate and 160 g soybean meal/kg; Volac Feeds Ltd, U.K.) and barley, (2) 150 g/kg LF70 and wheat, (3) 300 g/kg LF70 and barley, and (4) 300 g/kg LF70 and wheat. The diets were formulated to have identical digestible energy (3.82 Mcal/kg) and total lysine (16 g/kg). The pigs were offered the diets *ad libitum* for 33 d post weaning. Pigs offered 300 g/kg LF70 had a higher ADFI than the pigs offered 150 g/kg LF70 in the diet (0.489 vs. 0.424 kg/d; SEM, 0.014; $P < 0.01$). The inclusion of 300 g/kg LF70 resulted in a deterioration in food conversion ratio (FCR; 1.29 vs. 1.15 kg/kg; SEM, 0.05; $P < 0.05$) compared to the 150 g/kg LF70 inclusions. Cereal source had no effect on ADFI or FCR. There was a significant interaction ($P < 0.05$) between cereal source and lactose levels in ADG and final live weight. In wheat-based diets, the inclusion of 300 g/kg LF70 increased ADG and final live weight compared to 150 g/kg inclusions. However, in barley-based diets, the inclusion of 300 g/kg LF70 had no effect on ADG or final live weight. In conclusion, the inclusion of 300 g/kg LF70 increased ADFI compared to 150 g/kg LF70. However, higher lactose inclusion is more beneficial in wheat-based diets than in barley-based diets.

Key Words: Pigs, Lactose, Cereal

M87 Performance and nutrient digestibility of low tannin sorghum fed to pigs from 10 to 30 kg. E. T. Fialho*, P. B. Rodrigues, J. A. F. Lima, H. O. Silva, and V. Oliveira, *University Federal of Lavras - UFLA- BRAZIL.*

Two experiments were conducted to determine the effect of corn substitution by low tannin (LT) sorghum on pig performance from 10 to 30 kg BW. In a metabolism assay, nitrogen retention, digestibility of CP (DCCP), DE and ME of diets with sorghum substitution at 0, 33, 66 and 100% for corn. The metabolism assay was carried out in two periods by using 24 pigs (Landrace x Large White; 12.5 \pm 0.7 kg BW). A 7 d period for adaptation and 5 d period for total collection of feces and urine with ferric oxide (2%) as the indigestible marker was used. In the performance assay, 96 pigs (Landrace x Large White; 9.4 \pm 0.86 kg BW) weaned at 35 days were assigned to six replicates of the same four treatments as described for the metabolism assay. The experimental period was 30 days. The data revealed no effects ($P > 0.10$) over all treatments tested for nitrogen retention (21.20% for the diet with 100% corn as the cereal vs 19.07% for diet with 100% sorghum as the cereal), DCCP (85.00% for diet with 100% corn vs 85.80% for diet with 100% sorghum), DE (3821 Kcal/kg DM for diet with 100% corn vs 3793 Kcal/kg DM for diet with 100% sorghum) and ME (3619 Kcal/kg DM for diet with 100% corn vs 3670 Kcal/kg DM for diet with 100% sorghum). The data of feed intake (1.21 kg/d for 100% corn vs 1.25 kg/d for 100% sorghum), ADG (0.648 kg for 100% corn vs 0.620 for 100% sorghum) and feed:gain (1.86 for 100% corn vs 2.02 for 100% sorghum) also revealed no differences ($P > 0.10$) among all diets tested. Corn can be replaced by LT-sorghum up to level of 100% in pig diets from 10 to 30 kg BW with no influence on nutrient digestibility or pig performance.

Key Words: Pigs, Sorghum, Performance

M88 Effect of different sources and levels of lipids on the performance of pigs postweaning. M. E. Pimenta², J. A. Lima^{*1}, E. T. Fialho¹, P. Logato¹, and L. D. Murgas¹, ¹University Federal of Lavras - UFLA-Brazil, ²Universidade de Alfenas- UNIFENAS-Brazil.

A total of 144 crossbred piglets (72 barrows and 72 gilts; initial BW 6.90 \pm 1.32 kg) were utilized at 28 days of age to determine the effect of the addition of two sources of lipids (soybean oil and coconut oil) at different levels (2, 4, 6 and 8%) on postweaning performance. A 2 x 4 factorial arrangement of treatments (sources and levels of oils) plus an additional treatment (control diet without lipids addition). The experimental diets were isocaloric, isoprotein and isolysine, formulated based on corn, soybean meal, skimmed milk powder and fish meal supplemented with minerals, vitamins and lysine. There were no interactions between sources and levels of oil tested ($P > 0.05$) for any of the performance parameters. Also, no differences were shown ($P > 0.05$) in the ADG or feed/gain of pigs fed diets supplemented with soybean oil (ranging from 0.450 - 0.470 and 1.42 - 1.65) or coconut oil (ranging from 0.400 - 0.486 and 1.57 to 1.64) at the different levels tested. Comparing the performance of pigs fed diets with 2, 4, 6, 8% soybean oil and coconut oil with the control diet (without lipid addition), it was observed higher ($P < 0.01$) daily feed intake and poorer ($P < 0.01$) feed:gain when lipid was not added to the diet. The addition of lipids in the postweaning diets is a viable option due to better pig performance.

Key Words: Pigs, Coconut Oil, Soybean Oil

M89 Piglets at weaning or three weeks post-weaning prefer rice to sorghum. D. Solà-Oriol¹, E. Roura^{*2}, and D. Torrallardona¹, ¹IRTA, Centre de Mas Bové Apartat 415, Reus, Spain, ²Lucta SA Montornés del Vallés, Barcelona, Spain.

Palatability of feed ingredients may affect voluntary feed intake particularly when sudden dietary changes such as occur after weaning. The aim of the trial was to design an experimental model to establish feed ingredient preferences. A double choice test was performed between broken rice and sorghum at different inclusion levels in the diet (25, 50 and 100%) at two different piglet ages, 28 and 48 days (12 pens each). For each age group the pigs were distributed into four blocks of initial body weight. The diets were offered *ad libitum*, in mash form and feed intake measured over an 8d period for the 25 and 50% inclusion levels and over a 6d period for the 100% inclusion level. The preference of sorghum relative to rice was calculated as the percentage contribution of the sorghum diet to total feed intake. Preference values were analysed as a complete block design with four blocks and six treatments (2 ages by 3 levels of inclusion). Treatment effect comprised the components age, inclusion level and their interaction. ANOVA was performed using the GLM procedure of the statistical package SAS. The average preference for each of the treatments was compared to a neutral value of 50% using a Student's t test. With the newly weaned pigs, the preferences for sorghum (relative to rice) at 25, 50 and 100% inclusions were 45.8, 22.7 and 27.3 % respectively. The adverse preference observed for the 50% inclusion level was significantly different to the neutral value ($P < 0.01$). In the post-weaned pigs, the preferences for sorghum (relative to rice) at 25, 50 and 100% inclusions were 12.4, 19.7 and 29.9 % respectively. The preference values were significantly different to 50 ($P < 0.01$) for the 25 and 50% inclusion levels. No statistically significant effects were observed for animal age, inclusion level of the ingredients or their interaction. In conclusion, pigs prefer rice to sorghum and this preference is not dependent on animal age or the inclusion level in the diet.

Key Words: Palatability, Rice, Sorghum

M90 Enzyme supplementation of piglets fed diets containing barley, wheat, and corn. J. Sánchez¹, A. Fuentetaja², J. C. González¹, J. Peinado¹, and M. I. Gracia^{*1}, ¹Imasde Agropecuaria, S.L. Spain, ²Copese, S.A. Spain.

A study evaluated the efficacy of a feed additive enzyme (Amylofeed, EC No 34) containing 275 U/g of endo-1,3(4)- β -glucanase (EC 3.2.1.6), 400 U/g of endo-1-4- β -xylanase (EC 3.2.1.8), and 3,100 U/g of α -amylase (EC 3.2.1.1) on performance of piglets from weaning at 28 d to 60 d of age. Five hundred and twenty eight crossbred piglets (Duroc x Large

White*Landrace, half of each sex), weighing 7.36 ± 1.29 kg, were allocated randomly to 16 replicates of 33 piglets each. A completely randomized design was applied using two experimental treatments: 1) basal diet (control), 2) basal diet with 500 mg enzyme/kg feed, the recommended dose. The experimental design was applied in both the prestarter (28 to 44 d of age) and the starter (44 to 60 d of age) periods. Diets were based on barley, wheat and corn, and had 2.4 Mcal NE/kg and 14.8 g/kg lysine for prestarter, and 2.4 Mcal NE/kg and 13.3 g/kg lysine for starter. Data were analyzed as a completely randomized design with dietary treatment and sex as main effects and weaning weight as a covariate. General performance in the post weaning period was good. There were no significant differences between treatments with regard to feed consumption, growth, mortality or piglet cleanliness. But, for the overall period (28 to 60 d of age), piglets supplemented with the enzyme had better feed conversion ratio than control animals (1.18 vs 1.32 g feed/g gain; $P=0.01$). It was concluded that the addition of the enzyme to piglet diets improved feed efficiency from weaning until 60 d of age.

Key Words: Glucanase, Xylanase, Amylase, Enzyme, Piglets

M91 Technical feasibility of processed corn and soybeans in diets of piglets from 21 to 56 days of age. P. A. Castelo Branco, J. A. Lima, E. T. Fialho*, P. V. R. Logato, and R. T. Freitas, *University Federal of Lavras - UFLA-Brazil*.

Two experiments were carried out to evaluate the use of two corn types (common corn - C1 and pre-jellied flour of corn [higher temperature starch extrusion] - C2) and two soybean types (soybean meal - S1 and micronized soybean - S2) and their combinations in diets of post-weaning pigs from 21-56 days. The performance, relative weight of the digestive organs, and duodenum and jejunum villi height and crypt depth were evaluated. A total of 112 pigs (56 barrows and 56 gilts; mean initial BW of 7.2 ± 0.8 kg) weaned at 21 days were utilized in a 2×2 factorial design with seven replicates and four pigs per replicate pen. There was no interaction among types of corn or soybean on the performance (ADG, ADFI and feed conversion). The relative weight of the liver and large intestine of piglets at 33 days of age was influenced ($P<0.05$) for the two soybean types, being the highest for those fed soybean meal and the smallest when the micronized soybean was utilized. The relative weight of the stomach was influenced by the two corn and soybean types ($P<0.05$), being the highest weight observed for the C1+S1 combination (0.912 g) and the lowest for the C2+S2 combination (0.744 g). The treatment mixtures of C1+S2 (414.6) or C2+S2 (428.7) shown higher villi height and lower (122.2 and 152.6) crypt depths ($P<0.05$) respectively. According to the results it is technically feasible to utilize the pre-jellied flour of corn and the micronized soybean in diets since they provide gut health improvements in piglets from 21 to 56 days old. The economic viability should be considered at the current market feed prices.

Key Words: Feeds, Performance, Soybean

M92 Efficacy of a vegetable-based peptide product as a replacement for plasma protein in nursery pig diets. E. C. Halbrook*¹, C. V. Maxwell¹, M. E. Davis¹, Z. B. Johnson¹, D. C. Brown¹, R. Dvorak², and R. Musser³, ¹University of Arkansas, Fayetteville, ²Alltech Inc., Nicholasville, KY, ³Hubbard Feeds, Mankato, MN.

A total of 216 pigs were fed one of three dietary treatments to evaluate the efficacy of feeding a vegetable-based peptide product (NuPro#8482) as an alternative to plasma protein in nursery pig diets. Pigs were sorted by weight, and divided into three weight blocks. Pigs within each block were allotted into equal subgroups (six pigs/pen) with equal distribution of sex and litter. Four treatments were randomly assigned to pens within each weight block (9 pens/treatment). Three dietary treatments were fed from d 0 to 7 after weaning (Phase 1) and d 7 to 21 after weaning (Phase 2) and were comprised of: 1) a basal diet consisting of a complex nursery diet containing spray dried plasma protein devoid of NuPro, 2) the basal diet with 50% of the plasma protein replaced by NuPro, and 3) the basal diet with 100% of the plasma protein replaced by NuPro. During Phase 3 (d 21 to 42 after weaning), a common diet was fed to groups previously receiving treatments 1 and 2. One half of the pigs previously fed treatment 3 (100% replacement level of NuPro) were fed the common diet received by the treatment groups 1 and 2; while the other half were fed a diet containing 1.3% NuPro during the first week of Phase 3 (d 21 to 28), followed by the common diet for the

remainder of the phase (d 28 to 42). During Phases 1 and 2, no significant differences were observed among the four dietary treatments with regard to ADG, ADFI, or G:F, regardless of level of NuPro replacement for plasma protein. During the first week of Phase 3, pigs previously fed the basal diet containing plasma protein and fed NuPro at the 50% replacement level tended to have lower ($P = 0.07$) ADFI than pigs previously fed NuPro at the 100% replacement level and pigs fed NuPro at 1.3% of the diet during the first week of Phase 3. This study indicates that NuPro maybe used as an alternative to spray-dried plasma protein in nursery pig diets without detrimental effects on growth performance.

Key Words: Growth, Protein, Swine

M93 Effect of reduced protein in weaning pig diets. M. G. Zangeronimo, E. T. Fialho*, J. A. F. Lima, P. B. Rodrigues, and L. D. S. Murgas, *University Federal of Lavras-UFLA-BRAZIL*.

In order to evaluate the effect of a reduction of the CP content in diets of weaning piglets formulated on an ideal protein concept, a metabolism assay (1), an organs characteristics weight (2) and a performance assay (3) were conducted. In Assay 1, eight barrows (LD x LW; 12 ± 2.4 kg initial BW) were utilized to evaluate four treatments with pig as the experimental unit. In Assay 2, 60 weaning pigs (8.6 ± 0.8 kg initial BW) were utilized with a factorial scheme of the 4 dietary treatments and 3 slaughter periods resulting in five replications (each pig served as an experimental unit). In Assay 3, a total of 60 weaning pigs (8.0 ± 0.7 kg initial BW) were utilized to evaluate four dietary treatments; a total of five replicate pens of three pigs each with pen as the experimental unit resulted. For all assays the dietary treatments were formulated to contain different levels of CP, being one control (21% CP, 3400 Kcal DE/kg) diet and the others with reduced levels of CP (19.5; 18.0 and 16.5%) with all diets corrected by crystalline AA (lysine, methionine and threonine) according to NRC (1998). The digestibility of dry matter (DDM); N retention (NR); liver, spleen and pancreas weight; the duodenum villi height and crypt depth; pH of the stomach and cecum contents; and pig performance were analyzed. It was found that the treatments did not influence ($P>0.05$) any of the parameters studied, except for the crypt depth in first week postweaning ($P<0.05$) for those pigs fed diet with 18.0% CP. The ADG (kg) and feed conversion were 0.378 and 1.90 for control (21% CP); 0.393 and 1.97 for the 19.5% CP; 0.452 and 1.88 for 18.0% CP and 0.420 and 1.83 for 16.5% CP, respectively. In conclusion it is technically feasible to reduce the CP in the diets for weaning pigs if the essential AA are kept at similar levels. The environmental impact should be reduced by using lower levels of CP in the diets.

Key Words: Performance, Environmental, Lysine

M94 Effects of feeding rice protein concentrate on growth performance and ileal digestibility in early weaned pigs. C. Byung-Jo*, Y. Jung-Ho, Y. Ji-Soon, C. Jae-Yong, K. Jae-Young, and L. Jayant, *Kangwon National University, Chunchon, South Korea*.

These experiments were conducted to evaluate the feeding value of rice protein concentrate (RPC) in weaning pigs. In Exp. 1, a 5-week feeding trial was conducted with a total of 126 pigs (LYD; 21 d-old; 5.32 ± 0.34 kg). Treatments were spray-dried plasma protein (SDPP; control), soy protein concentrate (SPC) and RPC (Phase 1), and dried porcine soluble (DPS; control), SPC and RPC (Phase 2). An ileal digestibility trial was also conducted to compare digestibility of amino acids in the tested protein sources. In Exp. 2, a total of 160 weaning pigs (LYD; 21 d-old; 5.65 ± 0.35 kg) were used in a 5-week feeding trial to determine the optimal inclusion level of SPC in the diet. Treatments were control (9% SPC), and three levels of RPC instead of SPC in the diet (3, 6 and 9%). During Phase 1, pigs fed SDPP had better ($P<0.05$) ADG and FCR (308 g, 1.29, respectively) compared to those fed SPC (263 g, 1.49) or RPC (266 g, 1.51), while there was no difference in ADFI among treatments. During Phase 2, however, pigs fed DPS had lower ($P<0.05$) ADG (350 g) than those fed SPC (436 g) or RPC (434 g). The apparent ileal digestibilities of His, Lys, Phe, Thr, and Met were not different among the tested protein sources. In Exp. 2, there were no significant differences in ADG and FCR when SPC was substituted with RPC up to 9% during the total period. In conclusion, based on our

experimental results, RPC can replace SPC in the complex prestarter diet.

Key Words: Rice Protein Concentrate, Soy Protein Concentrate, Growth

M95 Effect of RPC (rice protein concentration) as a substitute for protein sources in weaning pigs. O. S. Kwon^{*1}, B. J. Min¹, K. S. Son¹, J. H. Cho¹, J. D. Kim², I. H. Kim¹, S. H. Ahn³, and H. S. Ahn³, ¹Dankook University, Cheonan, Korea, ²CJ Feed Co. Ltd., Korea, ³EUNJIN International Co. Ltd., Korea.

A total of 120 pigs (LYD, 7.79 kg average initial BW) were used in a 28-d growth assay to determine the effect of RPC (Rice Protein Concentration) as a substitute for protein sources on growth performance and nutrient and amino acid digestibility in weaning pigs. Dietary treatments (Trt) included: 1) A (basal diet; Control), 2) B (replaced protein source with 3% RPC), 3) C (replaced protein source with 4.5% RPC) and 4) D (replaced protein source with 6% RPC). Through entire experimental period, pigs fed diet containing 3% RPC tended to have increased ADG compared to pigs fed diet containing 4.5% RPC ($P < 0.05$). However, there were no differences in ADFI and G/F among the treatments ($P > 0.05$). Although there was no difference in blood urea nitrogen (BUN) among all treatments ($P < 0.05$), pigs fed the basal diet were numerically higher than other treatments. Nitrogen digestibility in Trt D tended to be higher than Trts A and C ($P < 0.05$). The apparent digestibility of asparagic acid tended to be higher for Trt D compared to other treatments ($P < 0.05$). However, there were no differences in other amino acids among the treatments ($P > 0.05$). In conclusion, the results obtained from this feeding trial suggest that dietary RPC for weaning pigs can be utilized as a substitute for protein sources.

Key Words: Rice Protein Concentration, Digestibility, Pigs

M96 Influence of a soy protein hydrolysate on the productive performance of early weaned pigs under an enterotoxigenic E. coli (ETEC) colibacillosis or under a healthy status. G. Ferrini¹, E. Borda², D. Martinez-Puig^{*2}, E. Garcia-Manzanilla¹, S. Martin-Orue¹, and J. Perez¹, ¹Universitat Autònoma de Barcelona Spain, ²BIOIBERICA Spain.

There are numerous reports that suggest an association between some protein sources (as soya) and the incidence of diarrhea in early weaning piglets. The mechanisms proposed are a likely hypersensitivity reaction, and/or a disbiosis promoted by the fermentation of undigested carbohydrates or proteins. We studied the effect of three prestarter diets (CP 193 g/kg, Lys 13.7g/kg) on the productive results of 192 early weaned (21d) piglets: 96 under an ETEC colibacillosis (Experiment 1) and 96 under a healthy status (Experiment 2). Diets contained soybean ingredients: SBM (extruded soybean meal 28.9 g/kg, and soybean meal, 107.8 g/kg), SPC (a soy protein concentrate, 92.3 g/kg), or SPH (a soy protein hydrolysate, 100 g/kg). Chromium oxide was used as internal marker for digestibility measurements. Animals were placed in 32 replicates (4 animals/replicate). During Experiment 1, an ETEC colibacillosis was clinically diagnosed on d 6 after weaning. Although scours were evident in all groups on d 7, most of the piglets fed SPH and SPC recovered after antibiotic therapy on d 9, whereas those fed SBM continued having severe diarrhea. Mortality was higher with SBM (18.7%), than SPC (9.37%) and SPH (3.1%). In Experiment 2, a higher digestibility of OM was found for the SPH (87.8%) than SPC (86.6%) and SBM (84.8%; $P < 0.05$). Nitrogen digestibility was also higher for SPH (83.4%) than SPC (81.2%) and SBM (79.1%; $P = 0.11$). During the second week after weaning, the ADG of the pigs fed SPH (247 g/d) and SBM (244 g/d) were higher ($P < 0.05$) than that of the pigs fed SPC (228 g/d). The overall results suggest that the hydrolysis of soy protein improves the health and productive performance of early-weaned piglets under healthy and unhealthy environment conditions. In conclusion, SPH appears to be an excellent protein source for the early-weaned pigs.

Key Words: Soybean, Protein, Piglets

M97 Liquid diets containing vegetable proteins accelerate piglet growth above milk-protein-based diets. A. Ebert¹, A. S. Berman¹, R. H. Harrell², S. G. Cornelius¹, and J. Odle^{*1}, ¹North Carolina State University, Raleigh, ²Milk Specialties Co, Dundee, IL.

Technologies to rear suckling piglets apart from the sow recently have been implemented on large commercial farms, and success has been measured in both accelerated growth and in reduced pre-weaning mortality. However, diets formulated with cow-milk proteins can be cost-prohibitive. This experiment compared the replacement of whey protein (WHEY) with isolated soy protein (ISP), a hydrolyzed vegetable-protein mixture (HYDROL) or the latter in 50% combination with whey protein (WHEY/HYDROL) in liquid diets fed to neonatal pigs from two to 19 d of age. Pigs were housed individually in an environmentally controlled room and were offered the liquid diets ad libitum via a gravity-flow feeding device. On d 19, pigs fed the vegetable-protein diets weighed 20% more ($8,179 \pm 211$ g; $P < 0.05$) than pigs fed the WHEY diet ($6,805 \pm 244$ g). The ADG was 35% higher for pigs fed the HYDROL diet than for pigs fed the WHEY diet, and ADFI was greater for WHEY/HYDROL and HYDROL diets compared to the WHEY diet ($P < 0.05$). Overall, pigs fed the HYDROL diet had a 16% higher G/F than pigs fed the WHEY diet. Although the apparent ileal digestibilities of most amino acids were 7-10% greater for the WHEY diet, digestible amino acid intakes were about 20% greater for HYDROL and ISP diets. Carcasses of pigs fed the WHEY diet contained a higher percentage of fat and ash and a lower percentage and accretion of protein. These results are likely related to a poorer balance of amino acids (especially arginine) in the WHEY diet. Leucine aminopeptidase activity in the distal small intestine was up to 58% greater in pigs fed the WHEY/HYDROL diet than in those fed the ISP diet. Similarly, villus height ($P < 0.02$) and area ($P < 0.006$) along the small intestine were greater in pigs fed the WHEY/HYDROL diet than in those fed ISP. Collectively, these data support the conclusion that both the hydrolyzed vegetable protein and isolated soy protein are good alternatives to whey protein in liquid diets formulated for neonatal pigs and that an appropriate balance of amino acids is more important than the source of protein per se.

Key Words: Protein, Liquid Feeding, Amino Acid Digestibility

M98 Interaction between threonine and avilamycin on piglet growth performance post weaning. J. M. O'Connell^{*}, J. J. Callan, and J. V. O' Doherty, Department of Animal Science and Production, University College, Dublin, Ireland.

The amino acid Threonine (Thr) is involved in the synthesis of intestinal mucin, which plays a key role in the innate immune defence of the mucosa. Synthesis and secretion of mucin is greatest when gut inflammation is high such as at weaning. The requirement for dietary threonine may be increased in the absence of in-feed antimicrobial growth promoters (AGP). A 3 x 2 factorial was used to investigate the interaction between Thr level [55, 65 and 75% of lysine (lys)] and AGP (0 or 60 ppm avilamycin) on piglet performance post weaning. Three hundred and sixty weaned piglets (24 d of age; 5.9 kg live weight) were blocked on the basis of weight and were assigned to one of six treatments. The treatments were as follows: (1) Thr:Lys ratio of 55% and avilamycin (300 ppm Maxus, Elanco Animal Health Ltd., USA), (2) Thr:Lys ratio of 55% and no avilamycin, (3) Thr:Lys ratio of 65% and avilamycin, (4) Thr:Lys ratio of 65% and no avilamycin, (5) Thr:Lys ratio of 75% and avilamycin, and (6) Thr:Lys ratio of 65% and no avilamycin. The diets were formulated to have identical digestible energy (3.82 Mcal/kg) and total lysine (16 g/kg). The pigs were offered the diets ad libitum for 28 days post weaning. There was no interaction between Thr and avilamycin ($P > 0.05$) in any variable measured. The inclusion of avilamycin in the diet had no effect on feed intake (FI; 0.546 vs. 0.552 kg/d; SEM, 0.009), ADG (0.402 vs. 0.405 kg/d; SEM, 0.007), food conversion ratio (FCR; 1.36 vs. 1.37 kg/kg; SEM, 0.02) or final liveweight (17.2 vs. 17.3 kg; SEM, 0.2). Thr:Lys ratio had no effect on FI (0.545 vs. 0.550 vs. 0.552 kg/d; SEM, 0.010), ADG (0.399 vs. 0.411 vs. 402 kg/d; SEM, 0.008), FCR (1.37 vs. 1.34 vs. 1.38 kg/kg; SEM, 0.02) or final liveweight (17.1 vs. 17.5 vs. 17.2 kg; SEM, 0.3). In conclusion, optimum piglet performance was obtained at a Thr:Lys ratio of 55% and there was no advantage to avilamycin inclusion in the diet under current conditions.

Key Words: Pigs, Threonine, Avilamycin

M99 Developmental regulation of fructose and amino acid transporter gene expression in the small intestine of pigs. X. Xiao*, E. A. Wong, and K. E. Webb, Jr., *Department of Animal and Poultry Sciences, Virginia Polytechnic Institute and State University, Blacksburg.*

To evaluate the developmental regulation of nutrient transporter gene expression in the small intestine, piglets from each of seven sows were killed at birth (d 0), during lactation (d 1, 3, 7, 14, and 21) and post-weaning (d 22, 24, 28, and 35; weaned at d 21). Intestinal segments (duodenum, jejunum, and ileum) were collected for RNA isolation. The abundance of mRNA was determined by Northern blotting using probes specific for transporters of fructose (GLUT5), neutral amino acids (LAT2) and cationic amino acids [$b^{0,+}$ AT, ATB(0)]. During lactation, there was an interaction ($P < 0.01$) between time and segments for abundance of GLUT5 mRNA. Abundance of GLUT5 mRNA generally increased from d 1 to 7 and subsequently declined to d 14 in the jejunum and ileum. In duodenal tissue, abundance decreased from d 0 to

3 and then increased to d 21. Abundance of LAT2 mRNA declined ($P < 0.001$) linearly from d 0 to 21. The LAT2 mRNA was predominantly distributed in the ileum ($P < 0.05$). Abundance of $b^{0,+}$ AT mRNA changed quadratically ($P < 0.001$) from d 0 to 21. Abundance of $b^{0,+}$ AT mRNA was greater ($P < 0.05$) in the ileum and jejunum than the duodenum. There was an interaction ($P < 0.001$) between time and segments in abundance of ATB(0) mRNA. Abundance generally increased from d 0 to 21 in the duodenum and ileum with the change in the ileum being greater. In the jejunum, abundance increased from d 0 to 7 and then decreased to d 21. During post-weaning, mRNA abundance of all transporters dramatically increased from d 21 to 22 or 24 and then rapidly decreased to d 24 or 28. Subsequent changes varied with transporter and intestinal segment. In conclusion, gene expression of these four nutrient transporters is not only differentially regulated by age but also differentially distributed among intestinal segments.

Key Words: Pig, Intestine, Amino Acid Transporter

Nonruminant Nutrition: Weanling Pigs - Additives

M100 Evaluation of organic acid blends and antibiotics for promoting growth of young pigs. D. W. Giesting*¹, M. J. Pettitt², and E. Beltranena^{2,3}, ¹*Cargill Animal Nutrition, Minnetonka, MN*, ²*Prairie Swine Centre, Inc., Saskatoon, SK, Canada*, ³*Provincial Department of Agriculture-Alberta, Edmonton, AB, Canada*.

Two, 5-wk, post-weaning growth experiments were conducted to evaluate the effects of blended organic acids (OA) alone or in combination with antibiotics on young pig performance. In the initial study, two acidifier blends were each included at 0.4% to starter diets alone, or in combination with LS20 antibiotic (22 mg/kg each lincomycin+spectinomycin). In the first 2-wk phase, each additive treatment improved gain (ADG) and feed conversion (F/G) v. negative controls ($P < .05$). ADG was 141, 178, 185, 187, 183 and 175 g/d for pigs fed the negative control (NEG), OA Blend A, Blend B, LS20, Blend A+LS20 and Blend B+LS20, respectively. F/G was improved ($P < .05$) for each of the OA, LS20 or OA+LS20 treatments. F/G was 1.80, 1.49, 1.45, 1.50, 1.37 and 1.42, for the treatments, ordered as above. Differences were not significant in the subsequent 3-wk period ($P > .10$). In experiment 1, OA blends improved performance similarly to LS20. In the second experiment, pigs were fed OAs (Blend C or Blend D), at 0.3% inclusion rate, ASP250 (110 mg/kg each of chlortetracycline and sulfamethazine, 55 mg/kg penicillin) or ASP250+Blend C. Pigs fed Blend C had 10% higher ADG (164 g/d) v. negative controls (148) ($P > .10$); pigs fed Blend D gained 17% faster (175) v. controls ($P < .10$). ASP250 improved ADG 33% (199) ($P < .05$). ASP250+Blend C improved ADG 61% (238) ($P < .05$). F/G was 1.38, 1.29, 1.33, 1.27 and 1.16 for negative control, ASP250, Blend C, Blend D and Blend C+ASP250, respectively. Only the combination of the OA blend and antibiotic improved ($P < .05$) F/G significantly. In period 2, gain was increased 6% by either blend ($P < .10$), 17% by ASP250 ($P < .05$) and 20% by ASP250+Blend C ($P < .05$). In this study, the antibiotic produced a stronger response than the OA blends, but an additive benefit was noted when the additives were used together. In these two experiments, OA blends improved ADG and F/G and enhanced the effects of antibiotics in promoting improved performance.

Key Words: Growth, Organic Acids, Antibiotics

M101 Interaction between lactose, avilamycin and inulin on piglet growth performance and nutrient digestibility post-weaning. K. M. Pierce*¹, J. J. Callan¹, P. McCarthy², and J. V. O'Doherty¹, ¹*University College Dublin, Ireland*, ²*Volac International Ltd, UK*.

One hundred and eighty piglets (24 d, 6.0 kg BW) were used to investigate interactions between lactose, avilamycin and inulin on growth performance and nutrient digestibility in post weaned piglets. The piglets were blocked on the basis of live weight and within each block assigned to one of six dietary treatments (6 pens/trt with 5 pigs/pen). The piglets were offered diets containing either a low (175 g/kg) lactofeed (LF70; 860 g/kg whey permeate, 140 g/kg soy bean meal; Volac International, UK) (LLF) or high (350 g/kg) LF70 (HLF) level with one of the following feed additives (FA) 1) 0 supplementation 2) 60 ppm avilamycin (Maxus, Elanco Animal Health, USA) (M) or 3) 15 g/kg inulin (I) in a

3 x 2 factorial arrangement. The starter diets were fed for 21 days and all diets contained chromic oxide at 150 ppm. There was an interaction ($P < 0.05$) between LF70 and FA in daily gain (ADG) between d 0-21. The pigs receiving HLF had a higher overall ADG compared to pigs receiving LLF at 0 supplementation (368 vs 281 g/d). However, there was no difference between the LLF and the HLF when the diets were supplemented with either M or I. Inulin improved feed efficiency ($P < 0.05$) between d 0-7 compared to Maxus or 0 supplementation (1.69 vs 2.50 vs 2.35 SEM 0.250). There was an interaction between LF70 and FA in fecal organic matter (OMD) and nitrogen (ND) digestibility ($P < 0.05$). The HLF and the HLF+M treatments improved OMD (89.02 and 89.32 %) compared to the LLF and LLF+M (87.44 and 87.61 %). However, there was no difference between LLF and HLF when the diet was supplemented with I (89.31 vs 88.49 % SEM 0.49). The HLF+I resulted in a reduced ($P < 0.05$) ND compared with the LLF+I. However, there was no difference between the LLF and the HLF when the diets received 0 or M supplementation. In conclusion, HLF improved ADG compared to LLF. Inulin inclusion improved FCR in the first week postweaning. The inclusion of inulin improved the OMD of diets low in LF70.

Key Words: Pigs, Lactose, Inulin, Avilamycin

M102 Effects of probiotic supplementation on gut histometry and fecal microflora in weaned pigs. V. Bontempo*¹, A. Di Giancamillo¹, C. Domeneghini¹, M. Fava¹, C. Bersani¹, R. Paratte¹, E. Chevauux², V. Dell'Orto¹, and G. Savoini¹, ¹*Department of Veterinary Sciences and Technologies for Food Safety, University of Milan, Italy*, ²*Allemand Animal Nutrition, Blagnac, France*.

Two hundred weanling piglets averaging 25 d of age and 5.0 ± 0.5 kg initial BW were assigned to two dietary treatments to determine the effects of supplementation with *Pediococcus acidilactici* on growth, gut histometry and fecal microbiota. Piglets were fed one of two liquid dietary treatments for 42 d after weaning: 1) Control (C), and 2) Control diet + *P. acidilactici* (1×10^{10} cfu/g) (P). Piglets were weighed and fecal samples from 16 homogeneous piglets (8 per group) were collected at 0, 14 and 42 d. These piglets were sacrificed for histology and histometry at the end of the experiment. No significant difference in growth was observed within the groups. Diet affected gut histometry of the P animals: histometrical analysis revealed an increase in villi height (C: 300 μ m; P: 327 μ m; SE: 7.52; $P < .01$) and crypt depth (C: 247 μ m; P: 287 μ m; SE: 10.31; $P < .01$) of the ileum, as well as in an increase of the cecum crypt depth (C: 387 μ m; P: 423 μ m; SE: 13.07; $P < .05$). A thicker mucous gel layer in the ileum of C piglets was also observed (C: 2.95 μ m; P: 2.35 μ m; SE: 0.07; $P < .01$). Fecal *Lactobacillus* populations were increased by *P. acidilactici* addition when compared to C diet (C: 10×10^8 cfu/g; P: 27×10^8 cfu/g; SE: 9.41×10^6 ; $P < .05$), while no difference was observed in the *E. coli* populations. In conclusion, the addition of *P. acidilactici* to piglet diet resulted in positive effects on gut structure and in a greater concentration of possibly beneficial bacteria.

Key Words: Piglets, *Pediococcus Acidilactici*, Gut Histometry

M103 Antimicrobials, probiotics, prebiotics and herbal extracts as growth promoters on performance of weanling pigs. C. E. Utiyama*, L. L. Oetting, P. A. Giani, U. S. Ruiz, and V. S. Miyada, *Escola Superior de Agricultura "Luiz de Queiroz" da Universidade de São Paulo, Piracicaba-SP, Brazil.*

One hundred and twenty 21-d-weaned pigs were used to compare five treatments with 12 replications (pens of two pigs each) per treatment in a 35-d randomized complete block design experiment. Treatments consisted of: control - basal diet of corn, soybean meal, dried whey, lactose and dried plasma; antimicrobial - basal diet plus antimicrobials (Zn bacitracin and olaquinox, 50 ppm of each); probiotic - basal diet plus 1300 ppm probiotic (*Bacillus subtilis* and *Bacillus licheniformis*); prebiotic - basal diet plus 3000 ppm mannanoligosaccharide; herbal extract - basal diet plus 500 ppm herbal extracts (garlic, clove, cinnamon, pepper and thyme). Antimicrobial agents improved ($P < .05$) ADG during d 1-35 (+21.4%) and d 15-35 (+22%) post-weaning compared to pigs fed the control diet. Although not significant ($P > .10$), ADG of pigs fed mannanoligosaccharide was 25.7% higher than those fed control diet during 1-14 days post-weaning period. Performance of pigs fed mannanoligosaccharide was intermediary between that of pigs fed the control and antimicrobial diets during d 15-35 and d 1-35 post-weaning. The herbal extracts did not improve pig performance ($P > .10$) in any period. Probiotic did not improve the growth performance ($P > .10$) of pigs. Mannanoligosaccharide seemed to be an alternative to antimicrobial agents as growth promoter of weanling pigs. However, dietary levels, how to incorporate in the diet, palatability, environmental conditions and mechanisms of action of all these alternative growth promoters should be better studied.

Key Words: Weanling Pig, Antimicrobial Agents, Alternatives

M104 The effect of bacillus and active yeast complex supplementation on the performance, fecal bacillus counts and ammonia nitrogen concentrations in weaned pigs. B. J. Min^{*1}, O. S. Kwon¹, K. S. Son¹, J. H. Cho¹, W. B. Lee¹, J. H. Kim², B. C. Park³, and I. H. Kim¹, ¹*Dankook University, Korea*, ²*Agribands Purina Korea, Inc., Seoul, Korea*, ³*CTC Bio. Inc., Korea.*

This experiment was conducted to investigate the effect of bacillus and active yeast complex supplementation on the performance, fecal bacillus counts and ammonia nitrogen concentration in weaned pigs. One hundred twenty LandraceYorkshireDuroc pigs (8.87±0.11 kg BW) were used in a 35 d growth assay. Dietary treatments included: 1) CON (control; basal diet), 2) AY (CON diet + 0.075% active yeast; BioSaf[®]), 3) BS (CON diet + 0.04% *bacillus subtilis* and *bacillus licheniformis* complex; BioPlus 2B#8482) and 4) YB (CON diet + 0.04% active yeast, 0.02% bacillus strains). During experimental days 0-14, ADG and ADFI were numerically higher in pigs fed active yeast diet than pigs fed other diets ($P > .05$). For days 15-35, pigs fed dietary bacillus and active yeast complex diet were numerically higher in ADG and ADFI compared with others ($P > .05$). For the entire period, ADG was greater for pigs fed active yeast, bacillus or complex diets than for pigs fed basal diet but without significant differences ($P > .05$). ADFI and Gain/Feed were not affected by treatments ($P > .05$). After 14 and 35 days of experiment, digestibility of dry matter was improved by 1.2-4.4% in pigs fed AY, BS and YB diets compared with pigs fed CON diet; also, digestibility of nitrogen was increased by 2.1-5.6% in AY, BS and TB treatments ($P < .05$). Pigs fed bacillus and complex diet were higher in fecal bacillus counts than pigs fed basal diet ($P < .05$). However, there is not a difference in fecal NH₃-N concentration ($P > .05$).

Key Words: Bacillus, Active Yeast, Pigs

M105 Efficacy of addition of *B. licheniformis* and *B. subtilis* in pig diets from weaning to slaughter. M. I. Gracia^{*1}, S. Hansen², J. Sánchez¹, and P. Medel¹, ¹*Imasde Agropecuaria, S.L. Spain*, ²*Chr Hansen A/S Denmark.*

A study was performed to evaluate the efficacy of a feed additive (EC No E1700) containing 1.6·10⁹ CFU/g of *Bacillus licheniformis* DSM 5749 and 1.6·10⁹ CFU/g of *Bacillus subtilis* DSM 5750 on performance of piglets from weaning at 28 d to slaughter at 95 kg. A total of 420 Large White x Landrace*Large White pigs, 50 % males and females, was used. There were two treatments: 1) basal diet (control), and 2) basal diet with 400 mg probiotic/kg feed. The experimental design was

applied in the prestarter (28 to 41 d of age, 1.48 % lys), starter (41 to 64 d of age, 1.33 % lys), and grower (64 to 116 d of age, 1.07 % lys) periods. From d 116 to slaughter at 167 d of age all pigs received a common diet (0.92 % lys). Each treatment was replicated 15 times with 14 pigs housed together constituting the experimental unit. Pigs supplemented with the probiotic were heavier than controls at the end of the prestarter period (10.2 vs 9.8 kg; $P < .05$) and at the end of the trial (94.7 vs 92.4 kg; $P < .05$). During the prestarter period, piglets fed the probiotic grew faster (204 vs 174 g/d; $P < .05$) and ate more feed (270 vs 247 g/d; $P < .05$) than controls. No significant differences were observed during the starter or the grower periods, but considering the overall period, probiotic supplementation of pig diets improved ADG (627 vs 611 g/d; $P < .05$) and ADFI (1,536 vs 1,491 g/d; $P < .05$). No differences were observed for feed conversion between dietary treatments for any of the periods studied. These results suggest that the probiotic tested improves growth of pigs from weaning until slaughter.

Key Words: Probiotic, Performance, Wean to Finish Pigs

M106 Isolation of *Bacillus* strains to inhibit pathogenic *E. coli* and enhance weanling pig performance. D. S. Parrott* and T. G. Rehberger, *Agtech Products, Inc., Manhattan, KS.*

E. coli causes edema disease and post-weaning diarrhea in swine. Previous research in our laboratory determined that these *E. coli* were a genetically diverse group. The objective of this research was to isolate *Bacillus* strains capable of inhibiting pathogenic *E. coli* and determine their effect on performance. Over 30,000 *Bacillus* isolates from environmental samples were screened using a replica plating technique against forty-eight *E. coli* strains isolated from six states. Twenty-five *Bacillus* strains were found to inhibit all of the *E. coli* strains. Two of the *Bacillus* strains were selected for feeding studies due to their higher level of inhibitory activity. Six replicate field trials involving a total of 1012 nursery pigs were conducted at a commercial farm. Each trial consisted of six pens with pigs blocked by weight into three blocks (heavy, medium, and light). For each trial, one pen of each block was assigned to either the standard nursery diet or standard nursery diet supplemented with the two *Bacillus* strains. Pigs were weighed by pen on days 0, 7, and 28. Feed consumed was recorded for each pen for the whole nursery time period. Mortality was also recorded. Data were analyzed using the PROC MIXED procedure of SAS and the effects of block and treatment, with day included, to take into account repeated measures and interactions, was evaluated. Pig weight was influenced by treatment ($P < .01$), block ($P < .0001$), treatment x block ($P < .01$) and block x day ($P < .01$). Heavy and light pigs fed the *Bacillus* strains had higher body weights than pigs fed the control diet at day 28 ($P < .005$ and $P < .01$). Feed intake in pigs in the light weight block was higher ($P < .01$) whereas intake of pigs in the other blocks was similar (treatment x block, $P < .05$). Feeding the *Bacillus* strains reduced mortality in the high ($P < .01$) and the medium ($P < .01$) weight blocks at day 28 (treatment x block x day, $P < .09$). This study indicates feeding the *Bacillus* strains can decrease mortality and enhance weanling pig performance.

Key Words: Swine, *E. coli*, *Bacillus*

M107 Effects of dietary herbal extracts (Animon Plus) on growth performance and blood composition in nursery and growing pigs. K. S. Son^{*1}, O. S. Kwon¹, B. J. Min¹, W. B. Lee¹, J. H. Kim², J. W. Hong¹, I. H. Kim¹, and H. S. Kim³, ¹*Dankook University, Cheonan, Korea*, ²*Agribands Purina Korea, Inc., Seoul, Korea*, ³*Kumbo Trading Co., Korea.*

Two experiments were conducted to investigate the effect of herbal extracts (including *Solanum xanthocarpum*, *Hedychium spicatum*, *Curcuma longa*, *Piper longum* and *Ocimum sanctum*) on the growth performance and blood composition in pigs. A total of 96 nursery pigs were randomly allocated into four treatments with six replications for four weeks (initial average BW 27.6 ± 2.63 kg). Dietary treatments included: 1) Con (Control), 2) AB (Control + 0.1% Antibiotics), 3) AM (Control + 0.1% Animon) and 4) ABAM (Control + 0.1% Antibiotics + 0.1% Animon). For the overall period, ABAM (562 g) treatment increased ADG compared to CON (500 g) and AB (506 g) treatments ($P < .05$). The difference of IgG concentration was increased in pigs fed AM and ABAM diets compared to pigs fed AB diet ($P < .05$). Pigs fed ABAM (3.5 g/dL) diet had higher albumin concentration than pigs fed

CON (2.9 g/dL) and AB (3.0 g/dL) diets ($P < 0.05$). Lymphocyte concentration difference of AB and ABAM diets had increased by 9.51% compared to CON and AM diets ($P < 0.05$). The digestibility of dry matter in ABAM treatment was increased by 5.3% compared to that of AB and AM treatments ($P < 0.05$). However, no differences were found for total protein of serum and N digestibility of feces ($P > 0.05$). In Exp. 2, a total of 75 growing pigs were randomly allocated to three treatments with five replications for 29 days (initial average BW 40.22 ± 2.82 kg). Dietary treatments included 1) CON (Control), 2) AM1 (Control + 0.1% Animon) and 3) AM2 (Control + 0.2% Animon). For the total experiment, the pigs fed AM1 (887 g) and AM2 (894 g) diets had greater ADG than pigs fed CON (831 g) diet. The AM1 diet increased ADFI compared to the CON diet. In serum characteristics, difference of IgG concentration of AM1 and AM2 treatments were greater than those of CON treatment ($P < 0.05$). Lymphocyte was greatest for AM1 and lowest for CON, with AM2 intermediate ($P < 0.05$). In conclusion, herbal extracts were effective in growth performance, IgG, albumin, total protein and lymphocyte responses in pigs.

Key Words: Herbal Extracts, Growth Performance, Pigs

M108 Efficacy of antimicrobials and herbal extracts as growth promoters of weanling pigs. L. L. Oetting*, C. E. Utiyama, P. A. Giani, U. S. Ruiz, and V. S. Miyada, *Escola Superior de Agricultura, Piracicaba-SP, Brazil.*

Two experiments involving a total of 80 weanling pigs (from 21 to 56 d of age) were conducted to compare antimicrobials and herbal extracts (HE) as growth promoters. Pigs were allotted to eight replications (pens of two pigs each) of five treatments in a randomized complete block design. Treatments consisted of: C - control, basal diet of corn, soybean meal, dried whey, lactose and dried plasma; A - basal plus antimicrobials (olaquinox, colistin, and Zn bacitracin, 50 ppm of each); HEa - basal plus 700 ppm HE; HEb - basal plus 1200 ppm HE; HEc - basal plus 2100 ppm HE. The HE consisted of a mixture of equal amounts of essential oils of thyme, clove (plus eugenol) and oregano (plus carvacrol). During d 1-14 post-weaning, DFI was higher ($P < .05$) for A than for HEa and HEb (.326, .256 and .265 kg/d, respectively). ADG and BW were improved ($P < .05$) when fed A compared to C and HEa (.229, .170 and .157 kg/d; and 8.63, 7.79 and 7.65 kg, respectively). For the overall 35d period, HEb resulted in lower DFI ($P < .05$), ADG and BW ($P < .10$) than A. ADG values were .350, .411, .335, .321 and .365 kg/d and BW values were 17.68, 19.83, 17.19, 16.68 and 18.19 kg for C, A, HEa, HEb and HEc, respectively. F:G was not affected ($P > .05$) by dietary treatments and the values were 1.60, 1.46, 1.59, 1.53 and 1.52 for C, A, HEa, HEb and HEc, respectively. Pigs fed high dietary level of HE (2100 ppm) showed intermediary results between A and C diets for all pig performance variables. The results of this study showed that, probably, higher levels of HE should be used to improve weanling pig performance.

Key Words: Herbal Extract, Weanling Pig, Performance

M109 Effect of dietary melatonin on serum melatonin level and growth performance of weaned pigs. G. H. Lee, J. G. Kim*, and K. Y. Whang, *Korea University, Seoul, Korea.*

A 21-d experiment was conducted to determine the effect of dietary melatonin on the serum melatonin level and growth performance of weaned pigs. Sixty-four pigs (8.2 ± 0.28 kg) were randomly allotted to one of four treatments: control (CON), 0.5 ppm melatonin (M1), 1 ppm melatonin (M2), and 2 ppm melatonin (M3). Diets were formulated to contain 3,525 ME kcal/kg, 1.49 % lysine, 0.26 % tryptophan and the other nutrients met or exceeded the NRC (1998) requirements. Pigs were allowed free access to the diet and water. Pigs were sampled weekly by jugular venipuncture between 1300 and 1600 h to determine the serum melatonin (SMT) level. Samples were analyzed by a direct radioimmunoassay. The SMT levels of the M1, M2, and M3 were linearly increased by dietary melatonin level at day 7, 14, and 21 ($P < 0.001$). Interestingly, the SMT level of M1, M2, and M3 reached the highest level at day 7, and decreased at day 14 and further decreased at day 21. The weight gain was shown to decrease as the dietary melatonin level increased. The ADG of M2 and M3 were lower ($P < .01$) than that of CON. However, ADFI tended to decrease as the dietary melatonin level increased (but not significantly). In conclusion, although the dietary melatonin increased the SMT, there was no positive effect on the growth in weaned pigs.

Item	CON	M1	M2	M3	SEM	P-value
Serum Melatonin, pg/mL						
d0	3.0	3.6	2.2	2.8	1.03	NS
d7	4.2 ^a	189.7 ^b	326.8 ^c	425.9 ^d	29.3	0.001
d14	7.1 ^a	116.4 ^b	183.5 ^c	279.7 ^d	21.3	0.001
d21	5.8 ^a	79.2 ^b	163.5 ^c	262.9 ^d	27.0	0.001
Growth Performance						
ADG, kg	0.63 ^a	0.61 ^{ab}	0.60 ^{bc}	0.57 ^c	0.01	0.01
ADFI, kg	0.81	0.81	0.78	0.75	0.02	NS
G/F	0.78	0.75	0.77	0.76	0.01	NS

Key Words: Dietary Melatonin, Pigs, Growth Performance

M110 Botanical additives masked by a flavor do not affect feed intake, growth, or fecal consistency in weanling pigs. E. Roura*¹, R. Fontanillas¹, and P. Bikker², ¹*Lucta SA Barcelona, Spain,* ²*Schothorst Feed Research, Lelystad, The Netherlands.*

Previous reports show that addition of botanicals to nursery diets may significantly reduce feed intake interfering with the assessment of potential benefits in piglets. A four-week trial was carried out at the Schothorst Feed Research, to study the effect on pig performance and fecal consistency after weaning of three botanicals (internal reference number [Ref] 44 with 3% capsicum, Ref 45 3% capsicum & 50% chicory extract, and Ref 46 50% chicory extract) dosed at 0.1, 0.2 & 0.4% for Ref 44 and 45, and 0.1 & 0.2% for Ref 46. Except for the negative control (T1) diet, a cherry-honey flavor was applied to all diets aimed at masking the botanicals (T3 through T10) or flavoring the control (T2). In total 300 piglets (26 d of age) were blocked by weaning weight (avg. 8 kg) and offspring and randomly allocated to treatments. Piglets received Phase 1 (0-14 d) and Phase 2 (15-28 d) growth promoters & acidifier-free diets. Compared to control T1 application of flavor alone (T2) numerically ($P > 0.05$) increased feed intake (5%) and daily gain (6%) in the four-week period. The flavor seemed to prevent depression of feed intake normally associated with botanical additives except for the highest inclusion of Ref 45 (T8) particularly when compared to the positive control T2 (12% decrease; $P < 0.05$). Inclusion of botanicals Ref 44 and 46 did not have significant effects compared to control T1 and tended to perform worse than piglets on the flavored control T2. Feed conversion ratio and fecal consistency were not affected by treatments. It is concluded that, overall, compared to a negative control, the three botanical additives tested did not improve gut health or performance of weanling pigs. The reduction on feed intake observed in previous works was largely avoided presumably due to a compensatory effect of the addition of the flavor. Treatment with a flavor alone tended to improve feed intake and daily gain.

Key Words: Piglets, Botanicals, Flavor

M111 Effect of bedding with mycotoxin contaminated straw and low levels of dietary mycotoxin on piglet performance. B. E. Strickler and P. Spring*, *Swiss College of Agriculture, Zollikofen, Switzerland.*

The aim of this study was to evaluate the effect of using mycotoxin-contaminated straw as bedding for weaning piglets fed diets with and without mycotoxin adsorbent on animal performance. The trial was set up as a complete randomized block design with 18 groups of 5 weaning piglets each (BW: 8.5 kg). Piglets received a starter diet (14.0 MJ/kg DE, 16.5% CP and 1.20% lysine) and water ad libitum. Treatments were as follows: Control: bedding with 200 g of wood shavings/hd/d; Straw: bedding with 200 g of contaminated straw/hd/d; Straw+Adsorbent: bedding with 200 g of contaminated straw/hd/d plus diet with 2000 ppm of mycotoxin adsorbent (Mycosorb#8482, Alltech Inc.). Straw was contaminated with 821 ppb deoxynivalenol (DON), 528 ppb zearalenone (ZEA) and < 50 ppb T-2 toxin. The piglets were also exposed to a natural infection with HPS (*Haemophilus parasuis*). Feed intake, ADG FCR, medical treatments and fecal scores were recorded. Data were analyzed by ANOVA and means were compared using the test of Tukey-Kramer. The mycotoxin-contaminated straw had no effect on piglet performance. However, the mycotoxin adsorbent led to improved performance during the first trial period. The feed was designed to contain low levels of

mycotoxin, however analyses revealed 220 ppb on DON, < 10 ppb ZEA and < 50 ppb T-2. The data suggest that in piglets exposed to weaning stress and a natural infection with HPS, DON levels as low as 220 ppb can decrease performance. From day 15-20, all piglets were treated with Vital TSS (Trimethoprim, Sulfathiazolum and Sulfadimidinum). This treatment effectively controlled the HPS infection. During this trial phase no differences in performance were recorded between treatments, indicating that a reduction in stress level did allow the piglets to cope with 220 ppm of dietary DON. Mycotoxin-contaminated straw did not affect piglet performance or health. However, low levels of dietary DON led to a reduction in performance in piglets exposed to weaning and microbial stress. Mycotoxin adsorbent can help in alleviating the negative effects on performance.

Table 1: Effect of contaminated straw and mycotoxin adsorbent on piglet performance

Parameter	Control	Straw	S + Adsorbent	SE
ADFI, g (d1-14)	346	334	378	15.3
ADFI, g (d15-28)	752	705	705	24.3
ADFI, g (d1-28)	549	520	542	17.6
ADG, g (d1-14)	218a	226a	276b	11.5
ADG, g (d15-28)	520	473	500	21.6
ADG, g (d1-28)	369	350	388	13.6
FCR (d1-14)	1.65c	1.54cd	1.38d	0.06
FCR (d15-28)	1.44	1.48	1.42	0.05
FCR (d1-28)	1.48	1.48	1.41	0.03

a,b P<0.05; c,d P<0.10

Key Words: Straw, Mycotoxin, Piglet

Forages and Pastures

M113 Nutritive quality of *Poa pratensis* in model grassland communities exposed to ground-level ozone. D. Dodson¹, J. Bender², J. Lin¹, and R. Muntifering¹, ¹Auburn University, Auburn, AL, ²Federal Agricultural Research Center, Braunschweig, Germany.

Tropospheric (i.e., ground-level) ozone (O₃) is the most significant phytotoxic air pollutant in the US and Europe, and its concentration globally is expected to increase by 0.3 to 1.0%/yr for the next 50 yr. Because interspecific plant competition is theorized to amplify O₃ stress, especially early in the growing season, a phytometer-based approach was utilized to investigate effects of exposure to elevated O₃ on nutritive quality of *Poa pratensis* (phytometer) and four competitor species (*Anthoxanthum odoratum*, *Achillea millefolium*, *Rumex acetosa* and *Veronica chamaedrys*) representative of an extensively managed, species-rich grassland community of Central Europe. Model plant communities (mesocosms), in which *P. pratensis* was grown in monoculture and in mixed cultures with each of the competitor species, were placed into open-top chambers and exposed continuously during April and May to carbon-filtered air + 25 ppb O₃ (control) or non-filtered air + 50 ppb O₃ (elevated O₃). *Poa pratensis* was harvested from mesocosms at the end of the exposure period and assessed for relative food value (RFV), which was predicted from concentrations of NDF and ADF. Across all mono- and mixed cultures, concentrations of NDF, ADF and lignin were greater ($P < 0.001$), and RFV was lower ($P < 0.001$) for *P. pratensis* grown under elevated O₃. Increased concentrations of lignin were considerably greater than could be explained on the basis of increased concentrations of NDF and ADF, consistent with the general mechanism of plant response to environmental stress. Concentrations of cell wall constituents and N were not affected by competition, and N concentration was not affected by exposure to elevated O₃. While effects of early-season O₃ stress on RFV of *P. pratensis* were not amplified by interspecific competition, exposure to elevated O₃ decreased RFV of *P. pratensis* by an

M112 Influence of diet on microbial community structure and activity in the intestinal tract of weaning pigs. A. Piva^{*1}, L. Magnani¹, G. Casadei¹, P. P. Gatta¹, K. M. Selig², and J. A. Patterson², ¹University of Bologna, Italy Via Tolara di Sopra, 50, Ozzano Emilia (BO), ²Department of Animal Sciences, Purdue University, West Lafayette, IN.

Weaning is the hardest step in the lifespan of a pig, and is often characterized by microbial imbalance, changes in intestinal structure and function, scours, low performance, or even death. Different nutritional strategies were studied relative to their ability to modulate intestinal microflora and performance. Three diets were fed over 5 weeks as follows: 1) standard U.S. diet with plasma protein, carboxox, zinc oxide and copper sulfate (US), 2) standard plant-protein-based European diet (EU) 3) EU diet + TRILAC (US Patent # 6,217,915) as a source of tributyrin and lactitol (TL). Performance was recorded at 7, 21, and 35 days, along with NH₃, VFA and Lactic Acid Bacteria (LAB) count in cecum, colon and jejunum. Despite any effects recorded during the first week, after 21 days US diet fed piglets reported significantly ($P < 0.05$) greater LW (11.36 kg, SE=0.42, n=30) and Feed Efficiency (0.53, SE=0.03, n=5), compared to EU (LW=9.38 kg; FE=0.39), or TL (LW=9.83 kg, FE=0.40) fed piglets. No differences were noticed between EU and TL treatments. A similar pattern was recorded at the end of the study (35 d) when US fed animals showed the highest ($P < 0.05$) LW (18.87 kg, SE=0.62, n=25) whereas Feed Efficiency did not differ among groups. NH₃ was not affected by any treatment throughout the study, whilst colonic VFA concentration after 21 days was higher in EU and TL groups compared to US piglets (+27% and +77%, respectively, $P < 0.03$). Moreover TL diet increased ($P < 0.01$) LAB count in the cecum (9.02 ± 0.36 log 10 cfu/g feces) and colon (9.15 ± 0.28 log 10 cfu/g feces) of piglets than did US diet (7.50 ± 0.44 and 8.03 ± 0.45 log 10 cfu/g feces, respectively). In conclusion a standard US diet added with plasma protein, carboxox, zinc oxide and copper sulfate out-performed a plant-protein-antibiotic-free European diet. Nevertheless the addition of tributyrin and lactitol together beneficially affected microbial balance and fermentation products leading to a LW numerically between those of US and EU formulations.

Key Words: Weaning Pigs, Intestinal Microbiota, AGP Alternatives

average of 10%, which is sufficient to have nutritional implications to its utilization by herbivores.

Key Words: Tropospheric Ozone, Forage Quality, *Poa pratensis*

M114 Effect of increased cutting height of corn silage on nutritive value, milk yield and milk composition. D. Dominguez-Diaz^{*2} and L. D. Satter^{1,2}, ¹Dairy Forage Research Center, USDA-ARS, Madison, WI, ²Dairy Science Department, University of Wisconsin-Madison, Madison.

The objective of this study was to evaluate the effect of increasing cutting height of a conventional corn hybrid (Golden Harvest H8250) from 20 cm (Normal cut corn silage, **NC**) to 61 cm (High cut corn silage, **HC**) on the nutritive value of corn silage, milk yield and milk composition. Thirty six multiparous and six primiparous Holstein cows averaging 70 days in milk (SD±16) and 45.2 kg milk/d (SD±6.4) were randomly assigned to the NC or HC diets following a 1-wk pretrial period. The experiment was a single reversal design with two 6-wk periods. The silages were chopped at 0.95 cm theoretical length of cut and stored in plastic bag silos. The NC and HC diets contained 65% forage, of which 70% was corn silage and 30% alfalfa silage. Increasing cutting height reduced DM yield by 8.3%, and increased grain content by 11.6% and decreased stalk by 38.5%. The concentration of DM, CP and starch were increased 9.1, 4.8 and 22.3% with the HC silage, and NDF, ADF and ADL concentrations were reduced by 9.9, 14.9 and 23.5%. Corn silage pH was slightly increased with the HC treatment. DMI was similar between the NC and HC diets (24.4 and 24.6 kg/d). The HC treatment increased yield of milk ($P \leq 0.03$) and 3.5% FCM ($P \leq 0.19$) compared to the NC diet (40.4 vs. 39.3 and 41.6 vs. 40.8 kg/d). Feed efficiency was increased ($P \leq 0.06$) with the HC treatment (1.66 vs. 1.62). Milk composition, body weight and body weight change were unaffected by treatment.

Key Words: Cutting Height, Corn Silage

M115 Site and extent of digestion of diets containing brown midrib-3, low-cut, or high-cut corn silage. D. Dominguez-Diaz*² and L. D. Satter^{1,2}, ¹Dairy Forage Research Center, USDA-ARS, Madison, WI, ²Dairy Science Department, University of Wisconsin-Madison, Madison.

The objective was to evaluate the effect of feeding brown midrib-3 corn silage (bm3) and conventional corn silage (Golden Harvest H8250) cut at 20 cm (Normal cut corn silage, NC) or 66 cm (High cut corn silage, HC) on ruminal fermentation, digestion kinetics, and site and extent of digestion. Nine multiparous Holstein cows averaging 172 DIM (SD±70) and 40.1 kg milk/d (SD±1.5) were randomly assigned to NC, HC and bm3 diets in a 3 × 3 Latin square design with 21-d periods. Dry matter digesta flow to the omasum was estimated using Ytterbium, CoEDTA and indigestible NDF markers. Omasal digesta samples were obtained by inserting a sampling device through the ruminal cannula. Fecal grab samples were used to estimate total tract digestibility. DMI was similar among NC, HC and bm3 diets (22.8, 22.9 and 23.7 kg/d). Milk yield and 3.5% FCM were similar among treatments (33.4, 31.8, 34.0 and 34.9, 32.8 and 35.9 kg/d). The daily mean of ruminal pH, acetate, propionate and total VFA concentrations were similar among treatments. The A/P ratio and ruminal ammonia concentrations were decreased ($P \leq 0.05$) with bm3 compared to the NC and HC diets (3.56 vs. 3.67 and 3.68, and 6.64 vs. 7.70 and 7.62 mM). Ruminal pool sizes of DM, OM, CP, NDF, ADF and starch were unaffected by treatment. Ruminal turnover rates of NDF and ADF were increased ($P \leq 0.003$) with feeding of bm3 compared to the NC and HC diets (5.34 vs. 4.52 and 4.56, and 5.0 vs. 4.17 and 4.24%/h). Apparent ruminal, post-ruminal and total digestibility of DM, OM and NDF were unaffected by treatment. Ruminal digestion of starch was reduced with the bm3 treatment, but resulted in 0.32 kg/d more starch digested in the small intestine. Ruminal and post-ruminal digestion of ADF were unaffected by treatment, but total tract digestion of ADF was increased ($P \leq 0.03$) with the bm3 compared to the NC and HC diets (46.5 vs. 42.6 and 43.6%).

Key Words: bm3, Cutting Height, Corn Silage

M116 Nutritive quality of early-season *Trifolium* forage as influenced by nitrogen and ground-level ozone. K. E. Kittendorf*¹, B. Sanchez-Gimeno², J. Sanz², J. Lin¹, and R. B. Muntifering¹, ¹Auburn University, Auburn, AL, ²Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Madrid, Spain.

Tropospheric (i.e., ground level) ozone (O_3) is the most significant phytotoxic air pollutant in the US and Europe, and its concentration globally is expected to increase by 0.3 to 1%/yr over the next 50 yr. Because N enrichment is theorized to increase susceptibility of vegetation to O_3 injury by altering leaf-cell apoplast pH, combined effects of O_3 and N on forage quality were investigated in an experiment in which seedlings of three *Trifolium* species representative of a Mediterranean dehesa community (*T. subterranean*, *T. cherleri* and *T. striatum*) were grown in open-top chambers (OTC) in which added air had been carbon-filtered (CF), representing approximately half-ambient O_3 concentration; non-filtered (NF), characteristic of ambient air; or enriched to twice-ambient O_3 concentration (2X). Within each air treatment, N fertilizer was applied to simulate a range of N enrichment levels (10, 30 and 60 kg N/ha) suggested from soil-test values and estimates of wet deposition in the vicinity of Madrid, Spain. Plants were exposed to air treatments for 30 d, removed from OTC, and maintained in ambient air until they were harvested 1 mo later. Exposure to elevated O_3 decreased ($P < 0.01$) biomass yield (2X < NF < CF), whereas N enrichment increased ($P < 0.01$) biomass yield (60 > 30 > 10 kg N/ha) in all three species. Exposure to elevated O_3 decreased ($P < 0.01$) relative food value (RFV) of *T. subterranean* (2X < NF < CF) and *T. cherleri* (2X < NF, CF), but not of *T. striatum* as predicted from increased ($P < 0.01$) concentrations of NDF, ADF and lignin. Nutritive quality of *Trifolium* forage was not affected by N enrichment and, contrary to the original hypothesis, N enrichment did not amplify negative effects of O_3 on biomass yield or RFV. Across all treatments, early-season exposure to 2X O_3 decreased RFV of *T. subterranean* and *T. cherleri* by an average of 13% compared with CF and NF exposures, which is sufficient to have nutritional implications to its utilization by herbivores.

Key Words: Tropospheric Ozone, Forage Quality, *Trifolium*

M117 Forage production and quality of triticale cultivars in the Tennessee Valley. M. Lema*¹ and E. Cebert², ¹Tennessee State University, Nashville, ²Alabama A & M University, Normal.

Because of its cold tolerance and double-cropping potential, triticale (*XTriticosecale Wittmack*) can play an important role in bridging the feed shortage gap in late fall and winter in the Tennessee Valley when other cool season grasses become dormant. Field trials were conducted in 2001 and 2002 at Winfred Thomas Agricultural Research Station (WTARS) and Sand Mountain Agricultural Substation (SMAS) in the Tennessee Valley to evaluate the forage yield and quality of six triticale cultivars (TCL105, TCL111, TX98D955, TX96VT5019, Tritical 498 and Tritical 2700). The cultivars were planted in four replicated 6-row plots 6.1 m long with rows 1.22 m apart in a randomized complete block design. At both locations, TX98D955, TX96VT5019 and Tritical 2700 produced higher ($P < 0.05$) forage DM than the other cultivars (2-yr average of 4,134; 3,851 and 4,063 kg/ha for TX98D955, TX96VT5019 and Tritical 2700, respectively versus 2,744; 3,070 and 3,077 kg/ha for TCL105, TCL111 and Tritical 498, respectively at WTARS and 6,326; 5,974 and 5,938 kg/ha for TX98D955, TX96VT5019 and Tritical 2700, respectively versus 4,531; 3,784 and 4,060 kg/ha for TCL105, TCL111 and Tritical 498, respectively at SMAS). Crude protein, ether extract and gross energy contents were lower ($P < 0.05$) for TCL111 and TCL105. Acid-detergent fiber content was higher ($P < 0.05$) and IVDMD lower ($P < 0.05$) for TCL 105. The cultivars TX96VT5019 and TX98D955 had higher ($P < 0.05$) P content and the cultivars TCL105, TCL111, TX96VT5019 and TX98D955 higher ($P < 0.05$) Ca content than the rest. The cultivars TCL105 and TCL111 were higher ($P < 0.05$) in Mg and lower ($P < 0.05$) in K than the other cultivars. Sulfur was higher ($P < 0.05$) for Tritical 498 and Zn higher ($P < 0.05$) for TCL498, TX96VT5019 and TX98D955. Iron content was lower ($P < 0.05$) for TX96VT5019 and TX98D955 than for the other cultivars.

Key Words: Triticale cultivars, Forage yield, Forage quality

M118 Effects of a bacterial inoculant on fermentation, quality, degradability and aerobic stability of whole head grain sorghum ensiled at two stages of grain maturity. L. O. Abdelhadi*¹ and J. M. Tricarico², ¹Est. El Encuentro, Research and Extension in Ruminant Nutrition. Cnel. Brandsen, Argentina, ²Allech Biotechnology Inc., Nicholasville, KY.

Pasture based systems around the world are being displaced to marginal areas where sorghum has agronomic advantages with respect to corn. Because high quality forages are needed to feed high producing animals, Argentina's producers need to improve silage quality. A completely randomized design with a 2x2 factorial arrangement of treatments was used to evaluate the effects of a commercial bacterial inoculant (Sil-All, Alltech Inc., Nicholasville, KY) on DM recovery, OM degradability (OMD), fermentation, chemical composition and aerobic stability of whole head grain sorghum ensiled at two stages of maturity. The same hybrid was harvested at both milk (MS) and dough stages (DS) of grain maturity and ensiled for 3 months in triplicate mini silos constructed from PVC pipe with or without bacterial inoculant. Samples were collected before ensiling, after ensiling for 3 months, and after exposing 3 month-old silage to air for 3d. Samples were analyzed for pH, DM, CP, NDF, WSC, NH_3 -N, and OMD after incubation with ruminal fluid for 24, 28 or 72h. Inoculation increased silage DM recovery over the control at MS (92.4 vs 97.9%, $P = .08$) but had no effect at DS of sorghum maturity. Ensiling sorghum at MS resulted in lower ($P < .01$) DM and WSC content, and greater ($P < .01$) CP content than ensiling at DS. Inoculation had no effects on DM, CP and NDF content, pH or NH_3 -N concentrations, but increased ($P = .05$) WSC content regardless of sorghum maturity at harvest. The OMD of sorghum harvested at MS was greater ($P < .01$) than that of sorghum harvested at DS after incubation for 24 or 48h. Inoculation improved aerobic stability of silage regardless of sorghum maturity as indicated by lower ($P < .01$) temperature in inoculated silage after exposure to air for 3d. We conclude that inoculation of whole head grain sorghum silage may be more advantageous when harvesting at an earlier stage of maturity.

Key Words: Silage, Grain Sorghum, Inoculant

M119 Estimating degradable intake protein on producer farms in northern Arkansas. W. K. Coblenz*, J. E. Turner, R. K. Ogden, K. P. Coffey, F. W. Pohlman, A. H. Brown, M. B. Daniels, J. L. Gunsaulis, M. L. Thomas, and J. B. Humphry, *University of Arkansas, Fayetteville.*

Two case studies were conducted on producer farms in northwest Arkansas during 2000-01 to assess concentrations of degradable intake protein (DIP) and undegradable intake protein (UIP) in forages grown throughout the region. In Case Study 1, DIP was greater ($P < 0.05$) by 11.7 and 0.76 percentage units of N and DM, respectively, for samples from cool-season pastures compared to samples collected from pastures dominated by warm-season grasses. For both photosynthetic types, NDF exhibited a strong negative correlation ($r < -0.605$; $P < 0.006$) with DIP; generally, both N and in-vitro organic matter disappearance (IVOMD) were strongly and positively correlated ($r > 0.665$; $P < 0.002$) with DIP, but N was not correlated with DIP ($P > 0.05$) in warm-season pastures when DIP was expressed as a percentage of total plant N. In Case Study 2, N fertilization at two producer sites increased concentrations of N in primarily linear ($P < 0.0001$) patterns for bermudagrass forages, but there was no carryover effect ($P > 0.05$) on a second harvest that received no additional fertilization. In harvests immediately following fertilization, DIP increased with N fertilization rate; the linear term was significant ($P < 0.004$) in each case, but it was coupled with quadratic or cubic effects in some harvests. Pool size for UIP also increased linearly ($P < 0.002$) with N fertilization in three of four harvests that immediately followed applications of N fertilizer, but the magnitude of these responses was small compared to those observed for DIP. As observed in Case Study 1, there were strong negative correlations ($r < -0.451$; $P < 0.0001$) between concentrations of NDF and DIP at both individual harvest sites, and on a combined basis. Conversely, DIP was correlated in a strong positive manner with concentrations of N ($r > 0.778$; $P < 0.0001$) and IVOMD ($r > 0.408$; $P < 0.0001$) at both sites, and in a combined analysis. Despite the diverse conditions of the two studies, DIP was positively correlated with concentrations of N and IVOMD, but negatively correlated with NDF.

Key Words: DIP, UIP, N fertilization

M120 Comparison of mechanically processed barley silage with regular barley silage on lactational performance of Holstein cows. J.-S. Eun¹, S.-H. Hong*², and K. Beauchemin¹, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*, ²*Sahmyook College Cheongnyangni, Seoul, Korea.*

Mechanical processing of whole crop barley prior to ensiling may be useful for improving nutrient utilization by dairy cattle. The objectives of this study were to assess the effects of feeding mechanically processed barley silage as the main forage source on lactational performance. Sixteen primiparous (187 ± 52 DIM) and 8 multiparous (87 ± 69 DIM) Holstein cows were used in a completely randomized design with a 2-wk covariate period and a 6-wk treatment period. The 2 treatments were: 1) RBS = TMR diet containing regular barley silage, and 2) MPBS = TMR diet containing mechanically processed barley silage. Barley silage and alfalfa hay supplied 41% and 5% of the diet DM. Intake, BW, and milk production were measured during the covariate and the treatment periods. In addition, 2 multiparous cows were used for in situ measurements of the ruminal DM and fiber degradation kinetics of the barley silages and diets. Results were analyzed with repeated measurements using a mixed model that included a covariate adjustment. Feeding MPBS had no significant effects on DMI (21.7 kg/d), milk yield (33.9 kg/d), or milk composition with only FCM (31.7 vs. 29.7 kg/d, $P = 0.51$) and milk fat concentration (3.57 vs. 3.30%, $P = 0.32$) showing a numerical improvement. Dairy efficiencies calculated as milk yield/DMI or FCM/DMI were not different between the diets. Body weight and BCS were not affected by treatments. Effective ruminal degradability of DM was similar for both barley silages, indicating that when the silages were ground to remove the effects of mechanical processing, the potential digestion was similar. In summary, mechanical processing did not improve the nutritional merits of barley silage for lactating dairy diets under the conditions of this experiment.

Key Words: Mechanically Processed Barley Silage, Degradability, Milk Production

M121 Effect of forage diversity on intake and productivity of grazing lactating dairy cows over two grazing seasons. K. J. Soder*¹, M. A. Sanderson¹, J. L. Stack², and L. D. Muller², ¹*USDA-ARS, Pasture Systems and Watershed Management Research Unit*, ²*The Pennsylvania State University, University Park.*

A study was designed to determine the effects of forage diversity on intake and productivity of grazing lactating dairy cows over two grazing seasons. In a randomized block design, twenty lactating Holstein cows (100 DIM, 634 kg BW) were assigned to one of four treatments for four 21-d periods. The four pasture treatments were: Orchardgrass(OG)/white clover (2SP); 2SP + chicory(CH; 3SP); OG + CH + red clover + tall fescue + perennial ryegrass + birdsfoot trefoil (6SP); and 6SP + white clover + alfalfa + KY bluegrass (9SP). Pasture allowance was 25 kg DM/cow/d. Cows were fed a 13% CP corn-based concentrate (1 kg/4 kg milk) in two equal feedings after milking. Pasture DMI was measured using Cr₂O₃ as a fecal marker. Pasture CP was higher while IVDMD was lower in Year 2. Pasture CP and IVDMD was higher for the more complex mixes. Pasture DMI was higher during Year 1, which was a drought year. Milk yield, milk fat and milk protein were not affected by year or treatment. Level of forage diversity did not have a major impact on DMI or productivity of grazing dairy cows. However, forage production and carrying capacity were greater on the complex mixtures than on the 2SP mix, particularly during drought.

	2SP	3SP	6SP	9SP	SEM	P-value
Pasture CP, %DM						
2002	21.8 ^{bc}	20.0 ^a	21.2 ^{ac}	22.5 ^{bc}	0.46	0.002
2003	23.2 ^a	24.5 ^a	25.7 ^b	24.1 ^a	0.46	0.002
Pasture IVDMD, % DM						
2002	66.6 ^a	70.4 ^b	70.9 ^b	67.2 ^a	1.20	0.02
2003	65.2 ^a	63.9 ^a	60.1 ^b	63.8 ^b	1.20	0.02
Pasture DMI, kg/d						
2002	14.7	13.7	13.6	12.9	0.49	NS
2003	11.1	10.5	10.5	10.0	0.49	NS
Milk Yield, kg/d	34.1	35.3	34.4	34.3	1.10	NS
Milk Fat, %	3.6	3.5	3.6	3.5	0.07	NS
Milk Protein, %	2.8	2.8	2.7	2.8	0.02	NS

Key Words: Pasture, Diversity, Intake

M122 Nitrogen characteristics and nitrogen degradation kinetics of crabgrass harvested in northern Arkansas. R. K. Ogden*, W. K. Coblenz, K. P. Coffey, J. E. Turner, D. A. Scarbrough, J. A. Jennings, and M. D. Richardson, *University of Arkansas, Fayetteville.*

Common crabgrass [*Digitaria ciliaris* (Retz.) Koel.] is undesirable in fields of bermudagrass [*Cynodon dactylon* (L.) Pers.], because it dries slowly, and can cause spontaneous heating and molding in hay. However, the visual observation suggests that livestock prefer crabgrass to many other summer forages. Our objectives were to assess N partitioning within leaf, stem, and whole-plant crabgrass; and to determine the in-situ disappearance of N for whole-plant crabgrass forages. Alfalfa (*Medicago sativa* L.), bermudagrass, and orchardgrass (*Dactylis glomerata* L.) also were evaluated for ruminal in-situ disappearance of N as diverse controls. Crabgrass was harvested at weekly intervals between 11 July and 22 August 2001. Concentrations of N and neutral detergent soluble N (NDSN) in whole-plant crabgrass decreased over sampling dates. These decreases exhibited a linear ($P = 0.001$) relationship with time for N, and linear ($P < 0.0001$) and cubic ($P = 0.006$) effects of time for NDSN. When crabgrass was evaluated for in-situ disappearance of N in five (383 ± 22.7 -kg) ruminally cannulated crossbred steers, the mean disappearance rate over seven sampling dates (0.092/h) was more rapid ($P < 0.0001$) than observed for bermudagrass hay (0.046/h), but was slower ($P < 0.0001$) than observed for alfalfa (0.223/h). The effective ruminal degradability of N was greater ($P < 0.0001$) for crabgrass (mean = 85.3%) than alfalfa (83.3%), bermudagrass (72.3%), and orchardgrass (76.0%) hays. Over the seven harvest dates, the effective ruminal degradability of N for crabgrass was 10.8 to 14.8 percentage units greater ($P < 0.0001$) than the bermudagrass hay evaluated simultaneously. These results indicate that crabgrass N exhibits high (\geq

83.1%) effective ruminal disappearance on all harvest dates, but exhibited a much slower disappearance rate than alfalfa.

Key Words: Crabgrass, Nitrogen, Degradation

M123 Chemical composition and in vitro digestibility of three cultivars of Guinea grass (*Panicum maximum* Jacq) at three ages of cut under tropical dry forest conditions. M. A Cuauro, B. Gonzalez, O. Araujo-Febres*, and J. Vergara, *La Universidad del Zulia, Facultad de Agronomía Maracaibo, Venezuela.*

A field experiment was carried out, during the rainy season in order to evaluate crude protein (CP), neutral detergent fiber (NDF), in vitro digestibility of dry matter (IVDDM) and in vitro digestibility neutral detergent fiber (IVDADF) contents in leaves of guinea grass (*Panicum maximum* Jacq) var. common, var. Mombasa and var. Tanzania. Plots (4 x 5 m) were established in randomized complete block design with a split plot arrangement of treatments, with harvest at 21, 42 and 63 days of age after an initial cut. Grass variety served as the main plot and cutting ages as subplot. Data were analyzed by least squares ANOVA using the GLM procedures of SAS. Total CP concentration in var. common is higher ($P < .05$) than var. Tanzania and var. Mombasa (17 vs 12% at 21 d, 12 vs 10% at 42 d and 11 vs 9% at 63 d). The var. common had lower NDF concentration than var. Tanzania and var. Mombasa at 21 d, but not at 42 and 63 d. The IVDDM were similar in all grasses at 21 and 42 d. In contrast, the var. common decreased ($P < .05$) IVDDM at 63 d. No differences ($P > 0.05$) were detected among cultivars.

Key Words: *Panicum maximum*, Crude Protein, In Vitro Dry Matter Digestibility

M124 Effects of a bacterial inoculant on fermentation, quality, degradability and aerobic stability of whole-plant grain sorghum and corn silages. L. O. Abdelhadi*¹ and J. M. Tricarico², ¹Est. El Encuentro, Research and Extension in Ruminant Nutrition. Cnel. Brandsen, Argentina, ²Alltech Biotechnology Inc., Nicholasville, KY.

Ensiling of sorghum and corn in Argentina frequently result in low quality silages that must be fed at low inclusion rates to avoid negative effects on animal performance. A completely randomized design was used in two studies to evaluate the effects of a commercial bacterial inoculant (Sill-All, Alltech Inc. Nicholasville, KY) on DM recovery, OM degradability (OMD), fermentation, chemical composition and aerobic stability of whole-plant grain sorghum (SS) and corn silages (CS). Sorghum and corn were harvested at the milk and dough stages of maturity, respectively, and ensiled for 3 months in triplicate mini silos constructed from PVC pipe with or without bacterial inoculant. Samples were collected before ensiling, after ensiling for 3 months, and after exposing 3 month-old silage to air for 3d. Samples were analyzed for pH, DM, CP, NDF, WSC, NH₃-N, and OMD after incubation in ruminal fluid for 24, 48 or 72h. Inoculation tended to increase DM recovery of SS by 3.0% and increased ($P < .05$) DM recovery of CS by 5.1%. The DM, CP, NDF and WSC contents, pH and NH₃-N concentrations were similar in control and inoculated SS. On average, inoculation increased ($P = .02$) the DM content, reduced pH ($P = .05$) and NDF ($P = .09$) content in CS. Trends towards increased OMD were observed for both SS and CS, being the numerical increases 3.4 and 3.5% for SS and CS, respectively after *in vitro* incubation for 48 and 72h. Inoculation did not affect the temperature of SS but reduced ($P = .01$) the temperature of CS after exposure to air for 3d, thus improving its aerobic stability. Although greater benefits were observed when inoculating CS compared to SS, the numerical increases in DM recovery and OMD obtained for SS may be of economic importance. We conclude that bacterial inoculation may be applied successfully to improve the quality of whole-plant sorghum and corn silages.

Key Words: Grain Sorghum Silage, Corn Silage, Inoculant

M125 Biomass yield and nutritive quality of eastern gamagrass (*Tripsacum dactyloides*) exposed to ground-level ozone. J. Lin*, J. Lewis, R. Muntifering, S. Ditchkoff, and A. Chapelka, *Auburn University, Auburn, AL.*

Tropospheric (i.e., ground-level) ozone (O₃) is the most significant phytotoxic air pollutant in the US, and its concentration globally is expected to increase by 0.3 to 1.0%/yr for the next 50 yr. Because very little is known about effects of ground-level O₃ on yield and nutritive quality of native grass species, we conducted an experiment in which eastern gamagrass (*Tripsacum dactyloides*) was grown in open-top chambers (OTC) to which added air had been carbon-filtered (CF), representative of that found at the cleanest air-quality sites in the US; non-filtered (NF), characteristic of ambient air in Auburn, AL; or enriched with O₃ to twice ambient concentration (2X). Primary-growth and regrowth forages were harvested monthly from each of nine OTC (three OTC/air trt). Mean daytime O₃ concentrations over the entire experiment (June 9 to September 4, 2003) were 14, 29, and 61 ppb, respectively, for CF, NF and 2X treatments. Across all three primary-growth harvests, biomass yield and concentrations of NDF and ADF were greater ($P < 0.05$) for 2X than CF, but not NF forage. A harvest period x treatment interaction ($P < 0.05$) was observed such that biomass yield and concentrations of NDF and ADF in the final primary-growth harvest were greater ($P < 0.05$) for 2X than NF and CF forages (23.2 vs. 16.1 and 13.8 g DM/plant; 73.7 vs. 68.2 and 65.2%; and 37.6 vs. 33.5 and 32.8%, respectively). Relative feed value (RFV) calculated from NDF and ADF concentrations in the final primary-growth harvest was lower ($P < 0.05$) for 2X than NF and CF forages (75.3 vs. 85.7 and 90.5, respectively). Concentrations of CP and lignin in primary-growth forages were not different among treatments, and no differences in biomass yield or chemical composition of regrowth forages were observed among treatments. Nutritive quality (RFV) of primary-growth eastern gamagrass forage was decreased by 14% in the 2X compared with NF and CF treatments, which is sufficient to have nutritional implications to its utilization of by herbivores.

Key Words: Tropospheric Ozone, Forage Quality, Eastern Gamagrass

M126 Effect of type of concentrate on grazing behaviour of dairy cows. R. G. Pulido*, E. Felmer, A. Hinostroza, and F. Wittwer, *F. Cs. Veterinarias, Universidad Austral de Chile, Valdivia, Chile.*

Two experiments were carried out to evaluate the effect of two sources of carbohydrate (fibrous and starchy) and two levels of crude protein in concentrate supplements (17.0% in exp 1 and 11.9% in exp 2) on grazing behaviour and herbage intake (HI) of spring calving dairy cows. In exp 1, 12 multiparous Friesian dairy cows (BW 529 kg), yielding 33 l/d and at 53 days of lactation, were assigned to a 3x3 Latin square design with periods of 21 days. In exp 2, 30 multiparous Friesian dairy cows (BW 512 kg), yielding 29.3 l/d and at 65 days of lactation, were assigned to a continuous randomized design for 45 days. For both experiments the treatments included: grazing alone (TGO), grazing plus 6 kg/d of sugar beet pulp-based concentrate (TFC) and grazing plus 6 kg/d of cereal-based concentrate (TSC). The concentrates were balanced by CP and ME. The cows were supplemented twice a day and managed under a strip grazing system on pasture consisting mainly of perennial rye grass. During the last week of each period in exp 1, and at one time point in exp 2, a record of individual grazing behavior was made every 10 minutes for all the cows during 24 hrs grazing activities. Throughout the trial BW was recorded weekly. HI and total dry matter intake (TDI) was estimated using Cr₂O₃. The results for HI during exp 1 were 15.4, 10.5 and 10.9 kg/d for treatments TGO, TCF and TCS, respectively ($P < 0.05$). TDI was 15.4, 15.8 and 16.2 kg/d, respectively ($P > 0.05$), grazing time (GT) was 562, 510 and 507 min/d, respectively ($P > 0.05$), ruminating time (RT) was 393, 367 and 418 min/d, respectively ($P = 0.06$) and body weight change was 0.18; 0.50 and 0.69, respectively ($P < 0.05$). The results for HI during exp 2 were 16.8, 11.2 and 12.1 kg/d for treatments TGO, TCF and TCS, respectively ($P < 0.05$). TDI was 16.8, 16.5 and 17.4 kg/d, respectively ($P > 0.05$), GT was 510, 456 and 466 min/day, respectively ($P > 0.05$), RT was 451, 491 and 442 min/day, respectively ($P = 0.06$) and body weight change was 0.72; 0.99 and 0.88, respectively ($P > 0.05$). The results suggest that carbohydrate source did not affect the grazing behaviour of dairy cows on this experiment. Key words: Cows grazing, intake, carbohydrates

Key Words: Grazing Cows, Intake, Carbohydrates

M127 The effects of xylanase addition on the fermentation of distillers wet grains in laboratory silos. V. Akay*, *Alltech, Inc., Nicholasville, KY.*

The objective of this study was to investigate the effects of the addition of xylanase on the fermentation of distillers wet grain (DWG). Distillers wet grains (36.36% DM) were obtained from New Energy Corporation (South Bend, IN). Treatments were: 1) control (CONT; water); 2) XYL1 (xylanase; 1.0 million XU/tonne); 3) XYL2 (xylanase; 2.0 million XU/tonne); 4) XYL3 (xylanase; 3.0 million XU/tonne). Three different levels of enzyme were prepared from a concentrate (200,000 XU/g) by dissolving 0.5, 1.0 and 1.5 g in 100 ml distilled water for XYL1, XYL2 and XYL3, respectively. Seven kilograms of DWG was placed into a mixer and 7 g of distilled water or enzyme solution was sprayed to obtain proper levels of enzyme concentrations for each treatment. Equal portion of treated DWG was packed into three 1 L Weck jars and sealed for each treatment (total 12 jars). Treated samples were incubated at room temperature. Jars were opened after 14 days of incubation and analyzed for pH, DM, ADF, NDF, N and soluble sugars. Data were analyzed as completely randomized design using the GLM procedure of SAS. Significant was declared at $P \leq 0.05$. Crude protein, arabinose and maltotriose did not differ among treatments. The pH content of ensiled samples was lower for XYL2 compared to CONT, XYL1 and XYL3. Neutral detergent fiber was lower in enzyme treated samples compared to CONT, and enzyme supplementation had both a linear and quadratic effect on NDF. Enzyme supplementation decreased lactic acid and had both a linear and quadratic effect on lactic acid. Dextrin was higher in enzyme treated samples compared to CONT, and enzyme supplementation had both a linear and quadratic effect on dextrin. Dextrin content was higher for XYL2 and XYL3 compared to XYL1. Glucose was higher in enzyme treated samples compared to CONT. Enzyme supplementation increased xylose compared to CONT. These changes in the composition of enzyme treated DWG may have some effect on animal performance.

Key Words: Distillers Wet Grains, Xylanase, Silo

M128 Herbage and animal performance responses to management intensity of continuously stocked bahiagrass pastures. R. L. Stewart, Jr.*, L. E. Sollenberger, J. C. B. Dubeux, Jr., and J. M. B. Vendramini, *University of Florida, Gainesville.*

Bahiagrass (*Paspalum notatum*) pasture covers approximately one million hectares in Florida, 90% of which is utilized by beef cattle. Increasing urbanization may force beef producers to achieve economic livelihood on reduced land area. One option is to increase intensity of management of the remaining pasture resource. The objectives of this research were to evaluate the effects of management intensity (MI), defined as a combination of N fertilization and stocking rates (SR), on yearling beef heifer and bahiagrass pasture performance. Treatments included LOW (40 kg N ha⁻¹ yr⁻¹, 1.2 animal units [AU, one AU=500 kg live weight] ha⁻¹ SR), MODERATE (120 kg N ha⁻¹ yr⁻¹, 2.4 AU ha⁻¹ SR), and HIGH MI (360 kg N ha⁻¹ yr⁻¹, 3.6 AU ha⁻¹), and each was replicated across two pastures. Herbage mass (3.0 MG ha⁻¹) and herbage allowance (4.0 kg forage kg⁻¹ animal weight) were greater for LOW and decreased ($P < 0.05$) as MI increased to HIGH (2.6 Mg ha⁻¹ and 1.1 kg forage kg⁻¹ animal weight). This occurred despite herbage accumulation rate being greater ($P < 0.02$) for HIGH (33 kg ha⁻¹ d⁻¹) than LOW (19 kg ha⁻¹ d⁻¹). Nutritive value increased with increasing MI, in part due to greater N rate and also because the higher stocking rates likely increased the frequency at which cattle revisited grazing locations. Average daily gain decreased ($P < 0.02$) from LOW to HIGH (0.46 to 0.36 kg d⁻¹) because of the lower herbage allowance for HIGH. Gain per hectare increased ($P < 0.02$) with increasing MI due to greater forage utilization. Bahiagrass cover increased ($P < 0.03$) with the HIGH MI (7.1%) and decreased with LOW (-6.4%) and MODERATE (-4.7%) due to invasion of bunchgrass weeds. In conclusion, the increase in liveweight gain per hectare did not compensate for the additional cost associated with increased management. Therefore, if the need for increased production per unit land area becomes acute, the use of another more management-responsive grass species likely will be required.

Key Words: *Paspalum notatum*, Nitrogen Fertilization, Stocking Rate

M129 Responses by steers compared under continuous and frontal grazing. H. Lippke, T. D. A. Forbes*, E. Rivera, P. G. Soderstrom, and B. G. Warrington, *Texas Agricultural Experiment Station, Uvalde, TX.*

Forage intake, digestible DM (DDM), and ADG by steers grazing ryegrass (*Lolium multiflorum* L.) under a frontal grazing system (FGS) were compared with responses under continuous stocking (CGS) at three stocking densities. All pastures were irrigated by a center pivot system. In the FGS, a break wire attached to the towers of the center pivot was advanced at a rate that would leave 30% of the leaf with the ungrazed residue (e.g., 10 cm min⁻¹ for 6 h daily). Each pasture was stocked with five Angus steers (testers), balanced for weight and sire effects. Additional steers (grazers) were placed in the FGS and high-density CGS pastures. Initial stocking densities were 1375, 1258, 895, and 717 kg BW ha⁻¹ for the FGS and the three CGS pastures, respectively. Dry matter intake (DMI) and DDM were estimated in January (Jan), February (Feb), and April (Apr), using alkane marker techniques. In Jan, mean DDM ranged from 773 to 779 g kg⁻¹, except for the medium CGS pasture with 740 g kg⁻¹ ($P < 0.05$). In Feb, DDM ranged from 747 to 773 g kg⁻¹, except for the high CGS pasture (650 g kg⁻¹, $P < 0.05$). In Apr, the medium CGS had greater DDM (710 g kg⁻¹, $P < 0.05$) than the FGS and low CGS pastures (680 g kg⁻¹); mean DDM of the high CGS pasture was 692 g kg⁻¹. In Jan, mean estimates of DMI ranged from 21.8 to 24.6 g kg⁻¹ BW among pastures and were not different ($P = 0.19$). In Feb, DMI for medium CGS (25.2 g kg⁻¹ BW) and low CGS (23.0 g kg⁻¹ BW) were greater ($P < 0.05$) than for high CGS (19.3 g kg⁻¹ BW); mean DMI for FGS (20.4 g kg⁻¹ BW) was different ($P < 0.05$) from medium CGS. In Apr, means for DMI ranged from 17.3 to 19.4 g kg⁻¹ BW and were not different ($P > 0.2$). Mean ADG for the medium CGS pasture (1.09 kg) was greater ($P < 0.05$) than for high CGS (0.89 kg), with low CGS (1.01 kg) and FGS (0.92 kg) intermediate. These data are consistent with the observed rank growth and earlier maturity of the low-density CGS pasture and the persistently lower herbage mass of the high-density CGS pasture. The FGS provided no performance benefit over CGS.

Key Words: Intake, Digestibility, Alkane

M130 Kura clover spreading ability with grass competition. B. Kim*¹ and K. Albrecht², ¹College of Animal Resources science, Kangwon National University, ²Department of Agronomy, University of Wisconsin-Madison.

Kura clover (*Trifolium ambiguum* M. Bieb.) is known to develop an extensive rhizome system when grown in monoculture. However, there is no information about the effects that competition from companion grasses could have on its rhizome development. This study was conducted to determine the difference in rhizome development of Kura clover planted in three different grass treatments of smooth bromegrass (*Bromus inermis* Leyss) and Kentucky bluegrass (*Poa pratensis* L.) swards and to evaluate the effect of defoliation height on Kura clover rhizome development. The experimental design was a randomized complete block with split, split-plot arrangement using three replications. The three grass treatments (killed-grass, grass and grass+N fertilizer) were randomly assigned to whole plots with two cutting height treatments (4-cm or 10-cm stubble height) assigned to sub plots. Two plants of each of the ten different entries of Kura clover (populations started from seeds or clones started from rhizomes) were randomly assigned to sub-sub plots. Rhizome development was measured in mid-September two years after transplanting in both swards at the University of Wisconsin Arlington Agricultural Research Station. Individual plants spread up to 1 m in diameter over a 2-year period after transplanting with no grass competition. The mean spread of kura clover by rhizome growth was greatest in killed-grass plots (85-cm diameter), least in the grass+N plot (29-cm diameter), and intermediate (57-cm diameter) in the grass only plots for both swards. The defoliation height of the swards did not significantly affect the spread of Kura clover regardless of grass status (killed or + or N) in either smooth bromegrass or Kentucky bluegrass. Kura clover generally spread more in smooth bromegrass sward compared to Kentucky bluegrass swards. Reducing the competition from grasses is a management tool that can be used to maximize the colonizing ability of Kura clover.

Key Words: Kura Clover, Rhizome

M131 The effects of addition of pectinase on the levels of soluble sugars during ensiling of whole sugar beets in laboratory silos. V. Akay* and P. Karnezos, *Alltech, Inc.*

The objective of this study was to examine the effects of pectinase on the levels of soluble sugars during ensiling of whole sugar beets in sealed Weck jars. Whole sugar beets were obtained from Best Agri Marketing, CA. Treatments were: 1) CONT (control, water); 2) PECT25 (pectinase; 2.5 million AJDU (apple juice depectinizing unit)/tonne); 3) PECT50 (pectinase; 5.0 million AJDU/tonne); and 4) PECT75 (pectinase; 7.5 million AJDU/tonne). Sugar beets were washed with tap water and shredded with a pruning shredder. Three different levels of enzyme were prepared from a concentrate (1 million AJDU/g) by dissolving 0.250, 0.500 and 0.750 g in 100 ml distilled water for PECT25, PECT50 and PECT75, respectively. Seven kilograms of shredded sugar beets was placed into a mixer and 7 g of distilled water or enzyme solution was sprayed to obtain proper levels of enzyme concentrations for each treatment. Equal portions of treated sugar beets were packed into six 1 L Weck jars and sealed for each treatment. Treated samples were incubated at room temperature. Jars were opened after 14 days of incubation and analyzed for pH, dry matter, soluble sugars and liquid content. Data were analyzed as a completely randomized design using the GLM procedure of SAS. Significance was declared at $P \leq 0.05$. Addition of pectinase to sugar beets decreased the pH, arabinose and acetic acid contents, and increased the lactic acid, fructose and galactose contents compared to control. Addition of pectinase to sugar beets also increased the liquid content of ensiled sugar beets compared to control.

Items	CONT	PECT25	PECT50	PECT75	SEM
pH	3.86 ^a	3.84 ^a	3.72 ^b	3.71 ^b	.008
Dry matter, %	16.90 ^a	16.84 ^{ab}	16.75 ^b	16.83 ^{ab}	.045
Dextrin, % of DM	25.40 ^{ab}	20.71 ^c	27.72 ^a	23.37 ^{bc}	.961
Arabinose, % of DM	20.98 ^a	19.33 ^a	16.30 ^b	15.19 ^b	.617
Maltose, % of DM	0.62 ^a	0.42 ^b	0.63 ^a	0.35 ^b	.034
Maltotriose, % of DM	0.62 ^a	0.62 ^a	0.63 ^a	0.42 ^b	.003
Glucose, % of DM	0.41 ^{bc}	0.21 ^c	0.63 ^{ab}	0.83 ^a	.104
Fructose and					
Galactose, % of DM	4.49 ^c	6.72 ^b	6.83 ^b	9.22 ^a	.550
Lactic acid, % of DM	6.70 ^b	6.92 ^b	9.40 ^a	9.50 ^a	.198
Acetic acid, % of DM	3.17 ^a	3.05 ^a	2.72 ^b	2.43 ^c	.087
Liquid, %w	62.10 ^b	70.65 ^a	73.73 ^a	73.45 ^a	1.100

^{abc}Means in row without common superscripts differ ($P < .05$).

Key Words: Sugar Beet, Pectinase, Silo

M132 Comparison of forage drying methods. T.W. White*, A.J. Phelps, H.G. Bateman, and C.C. Williams, *Louisiana State University Agricultural Center.*

Effects of drying method on forage analysis were compared using fresh-cut samples of immature and mature alfalfa, red clover, crimson clover, white clover, Coastal bermudagrass, Grazer bermudagrass, bahiagrass and ryegrass. Eight samples of each forage were cut at two stages of maturity. Four samples were oven-dried at 50 °C and four samples were freeze-dried. After the initial drying, the forages were ground to pass a 2-mm screen and DM determined at 100 °C. Ash, CP, NDF and ADF were determined on the oven-dried (50 °C) and freeze-dried samples and reported on DM (100 °C) basis. A 2x2x8 factorial arrangement of treatments was analyzed as a completely randomized block design. Immature forage contained more ash ($P < 0.01$) and less ($P < 0.01$) NDF and ADF than mature forage. Legumes were lower ($P < 0.01$) in NDF, generally lower in ADF and higher ($P < 0.01$) in CP than grasses. Ash and NDF were higher ($P < 0.02$) and CP was lower ($P < 0.01$) in oven-dried forages than in freeze-dried forages. These results suggest that drying method may affect apparent forage composition.

Key Words: Forage, Drying methods, Analysis

M133 Effect of winter stocker growth rate and finishing diet on beef longissimus fatty acid composition. C. Realini¹, S. Duckett*¹, J. Neel², J. Fontenot³, and W. Clapham², ¹University of Georgia, ²USDA-ARS, ³Virginia Tech University.

Seventy-two Angus-cross steers were stockered during the winter months at three growth rates (LOW [0.36 kg/d], MED [0.55 kg/d] or HIGH [0.82

kg/d] prior to finishing on pasture (PAST) or corn silage-concentrate diet (CONC) to determine the effects on longissimus muscle fatty acid composition and cholesterol content. Fatty acid profile and cholesterol content of ribeye steaks (12th rib) were determined by GLC. Data were analyzed as a 3 x 2 factorial design with stocker growth rate (LOW, MED, HIGH), finishing diet (PAST or CONC) and two-way interaction in the model. Total lipid content was two-fold greater ($P < 0.01$) for CONC than PAST, and similar between stocker growth rates. Longissimus muscle from CONC had greater ($P < 0.01$) proportions of myristoleic, palmitic, palmitoleic, oleic, and total monounsaturated fatty acids than PAST. Saturated fatty acid concentration was greater ($P < 0.05$) for PAST-LOW than PAST-MED or CONC-HIGH. Trans-11 octadecenoic acid and the cis-9 trans-11 isomer of CLA were 234% and 90% greater ($P < 0.01$), respectively, for PAST than CONC. Omega-3 fatty acid concentration was 136% greater ($P < 0.05$) for PAST than CONC due to increases in EPA (C20:5), DPA (C22:5), and DHA (C22:6). For omega-6 fatty acids, PAST-MED had greater ($P < 0.05$) levels of omega-6 and linoleic acid than PAST-LOW or CONC-HIGH with CONC-LOW and PAST-HIGH being intermediate. The ratio of omega-6 to omega-3 fatty acids was lower ($P < 0.05$), more desirable from a human health standpoint, for PAST than CONC. Cholesterol content tended ($P = 0.06$) to be greater for PAST than CONC with no differences among stocker growth rates. Increasing growth rate during winter stockering prior to finishing had only minor influences on longissimus fatty acid composition. Finishing cattle on pasture reduced the total fat content of the longissimus and increased the concentrations of omega-3 fatty acids, CLA and trans-11 octadecenoic acid.

Key Words: Beef, Fatty Acids, Forages

M134 Effect of winter stocker growth rate and finishing diet on beef rib composition, quality and palatability. C. Realini¹, S. Duckett*¹, J. Neel², J. Fontenot³, and W. Clapham², ¹University of Georgia, ²USDA-ARS, ³Virginia Tech University.

Angus-cross steers (68 steers in 2002; 62 steers in 2003) were stockered at three growth rates (LOW, MED or HIGH) during the winter months prior to finishing on pasture (PAST) or corn silage-concentrate diet (CONC) to determine the effects on 9-10-11th rib composition, color, and palatability. Steers were harvested at a commercial meat plant and rib (IMPS107) removed from each carcass. The percentage of lean, fat and bone was determined by physical dissection of the 9-10-11th rib section. Data were analyzed as a 3 x 2 x 2 factorial design with stocker growth rate, finishing treatment, year and all interactions in the model. Percentages of bone and lean in the 9-10-11th rib section were greater ($P < 0.05$) for PAST than CONC finished. Rib sections from steers finished on PAST had a 46% reduction ($P < 0.05$) in fat trim (subcutaneous and intermuscular) compared to CONC finished. Reduced growth rate (LOW) during winter stockering reduced ($P < 0.05$) percentage of bone and tended ($P = 0.08$) to increase the percentage of fat in the rib section. Rib section weight increased ($P < 0.05$) with higher winter growth rates for CONC but did not differ among stocker growth rates for PAST. Overall, rib section weight was 28% heavier for CONC than PAST. Longissimus muscle from PAST was darker ($P < 0.01$), less ($P < 0.01$) red, and less ($P < 0.01$) yellow compared to CONC. Subcutaneous fat color was darker ($P < 0.01$) and more yellow ($P < 0.01$) for PAST than CONC. The interaction between finishing treatment and year was significant ($P = 0.01$) for Warner-Bratzler shear force (WBSF). In 2002, WBSF at 14-d of postmortem aging did not differ between PAST and CONC; however in 2003, WBSF was greater ($P < 0.05$) for PAST than CONC. Increasing growth rate during winter stockering had only minor effects on rib weight and composition. Finishing diet altered rib weight and composition, lean and subcutaneous fat color, and tenderness.

Key Words: Beef, Forages, Tenderness

M135 Effect of winter period rate of gain on finishing growth rate, final weight and carcass parameters from pasture or feedlot finished cattle. J. P. S. Neel*¹, J. P. Fontenot², W. M. Clapham¹, and S. K. Duckett³, ¹USDA-ARS, AFSRC, ²Virginia Tech, ³The University of Georgia.

English-type crossbred steer calves (71 head in 2002; 62 head in 2003) were used to compare growth rate, final weight and carcass parameters from cattle finished on pasture (PAST) or corn silage-concentrate (CON) in feedlot, after being wintered at projected low (LOW, ADG =

0.36 kg), medium (MED, ADG = 0.55) or high (HIGH, ADG = 0.82) growth rates. Steers were harvested on the same dates, across treatments, at a commercial meat plant. Data were analyzed as a 3 x 2 x 2 factorial design with winter treatment, finishing treatment, year and all interactions in the model. Winter treatment influenced ($P < 0.05$) finishing ADG (ADG), final weight (FW), carcass weight (CW), dressing percentage (DP) and quality grade QG. Steer ADG during finishing was greater ($P < 0.05$) for LOW than MED and MED than HIGH wintering treatments. Animal FW and QG was greater ($P < 0.01$) for HIGH than LOW winter treatment. Carcass weight and DP was greater ($P < 0.05$) for HIGH. Finishing treatment influenced ($P < 0.001$) yield grade (YG), rib fat (RF), ribeye area (REA), kidney, pelvic and heart fat (KPH) and QG with values being higher for the CON treatment. The interaction between finishing treatment and year was significant ($P < 0.05$) for ADG, FW, CW and DP. Pasture finished cattle had lower ($P < 0.001$) ADG, FW, CW and DP in year two than one, while no differences were seen between years for the CON treatment. Year influenced ($P < 0.05$) RF, KPH and QG. Cattle had higher ($P < 0.05$) RF and QG, and lower KPH in year 1. Lower winter period gain resulted in greater finish period gain. Finishing cattle on CON resulted in greater ADG, FW, CW, DP, YG, QG, RF, REA and KPH. Carcass quality grades were lower in year 2 than year 1.

Key Words: Finishing, Pasture, Winter

M136 Effects of γ -terpinene, terpinolene, α -copaene, and α -terpinene on consumption of alfalfa pellets by sheep. R. E. Estell¹*, E. L. Fredrickson¹, D. M. Anderson¹, K. M. Havstad¹, and M. D. Remmenga², ¹USDA/ARS Jornada Experimental Range, ²New Mexico State University, Las Cruces.

Secondary chemistry influences shrub consumption by free-ranging ruminants. However, effects of many specific terpenes on herbivory have not been examined. 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 γ -terpinene, terpinolene, α -copaene, or α -terpinene 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 (0.64 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 3.9% of BW (DM basis). A day effect ($P < 0.02$) was detected for intake with γ -terpinene ($P < 0.0001$ for both linear and quadratic contrasts). A treatment effect ($P < 0.02$) was observed for α -copaene, with intake on the 2X treatment lower than other treatments. No effect of terpinolene or α -terpinene on intake was observed during the 20-min interval. None of the chemicals tested were strongly related to intake of alfalfa pellets by lambs under the conditions of this study.

Key Words: Intake, Sheep, Terpenes

M137 Forage quality differences between grass hay stored as dry large round bales or wet wrapped round bales. E. B. Rayburn, W. L. Shockey*, and R. M. Wallbrown, West Virginia University, Morgantown.

High humidity associated with the Appalachian region of the US, requires hay producers to wait 2 to 3 days between mowing and baling. Most hay is stored at 80 to 85% dry matter (DM) as large round bales (DRB). Hay harvested as wrapped, large round bales (WRB) usually range from 40 to 60 % DM. The ability to store WRB at high moisture reduces field drying time to 1 to 2 days. Reduced drying time and increased forage moisture increases leaf retention and decreases field losses. In an on-farm research study 7 forage producers representing 7 WV counties harvested hay as either DRB or WRB that was cut from the same field on the same day. Samples (n = 16) were analyzed for DM, crude protein (CP), available protein (AP), degradable protein (DP), soluble protein (SP), acid detergent fiber, neutral detergent fiber (NDF), crude fat (CF), total digestible nutrients (TDN), net energy lactation (NEL), net energy maintenance (NEM), net energy gain (NEG), calcium, phosphorus, magnesium, potassium, sulfur, relative feed value, ash, lignin, NDF insoluble CP (NDICP), starch, nonfiber carbohydrate, and sugar. WRB hay contained higher levels of CP (12.1 vs 10.7% DM; $P < .05$), CF (3.6 vs 2.2% DM; $P < .01$), NEM (.51 vs .42Mcal/lb;

$P < .05$), SP (6.0 vs 2.2% DM; $P < .001$), and SP (50.6 vs 21.4% CP; $P < .001$) and lower levels of NDICP (2.7 vs 4.5% DM; $P < .01$) compared to DRB. WRB hay tended to contain higher levels of AP (11.1 vs 9.7% DM; $P = .07$), TDN (56.8 vs 52.2% DM; $P = .07$), NEL (.53 vs .43 Mcal/lb; $P = .43$), NEG (.26 vs .17Mcal/lb; $P = .05$), DP (68.8 vs 55.4% CP; $P = .05$) and lower levels of lignin (8.5 vs 7.2% DM; $P = .1$) compared to DRB. The economic impact of the improved quality only covered the cost of the plastic. To maximize the value of wrapping hay it is necessary to harvest at earlier stages of growth so that forage quality improvements will pay for the additional machinery, labor and material cost. For WV cattle producers, WRB could be a cost effective way to improve nutrition of hay-fed animals if the productive state of those animals require additional nutrients.

Key Words: Forage, Hay, Large Round Bales

M138 Assumption testing of the optimal sampling schedule of diet components. B. Cobanov* and N. R. St-Pierre, The Ohio State University, Columbus.

The accounting of forage inventory can be conceptualized as a quality control issue that can be monitored using a Shewhart X-bar chart. This procedure requires three inputs: number of samples n , sampling frequency h , and control limits L . All three affect the performance of the chart and, thus, the total quality cost (TCQ). A TCQ function consists of cost/cycle while the process is in-control (IC) A , cost/cycle while the process is out of control (OC) B , cost/cycle for sampling and analyses F , and expected duration of a cycle D . $A = C_0/J$, where C_0 is quality cost/d while producing is IC, and $J=1/\text{mean time process is IC}$. $B = C_1(E-\tau A_2 h + T_1 + T_2) + sY/A_1 + W$, where C_1 is quality cost/d while producing is OC, E =time to sample and analyze one item, $\tau = [1 - (1+Jh)e^{-Jh}]/[J-Je^{-Jh}]$ is the expected time for assignable cause to occur given that it occurs between the i^{th} and the $(i+1)^{\text{th}}$ sample, $A_2 = 1/(1-\beta)$ is the average run length while OC, T_1 is the expected time to discover the assignable cause, T_2 is the expected time to fix the diet, β is the probability(IC_signalprocess_is_OC), $s = (e^{-Jh})/(1-e^{-Jh})$ is the expected number of samples taken while IC, $A_1 = 1/\alpha$ is the average run length while IC, α is the probability(OC_signal-process_is_IC), and W =cost to fix the diet. $D = 1/J - \tau + E + A_2 h + T_1 + T_2$. $F = (a+bn)/hD$ where a is the fixed cost per sample, and b is the cost/(unit sampled). The daily TCQ = $(A+B+F)/D$. The model assumes the normal distribution, but the true distribution remains unknown. We have performed extensive simulation varying J parameter from 5 to 90 d using: Standard Normal (SN); SN with +/- 3.5 SD outliers inserted with a frequency of 1, 5 and 10%; LogNormal with σ taking values 0.3, 0.6, 1.0, 2.0, 4.0, SN with graduate change of mean from 0 to 1.5 SD over 7, 14 and 28 d. The simulation showed that the optimal solution is not sensitive to outliers (the average TCQ cost change was less than 1%) or to long tails (LogNormal test showed the average TCQ cost change in range 6.12 to +1.74%). Finally, the gradual mean change test yielded the most significant cost increase (27.8 to 42.9%).

Key Words: Sampling & Simulation, Quality Control, Assumption Testing

M139 Effects of source and level of two legumes or cotton seed meal on intake and digestibility of Coastal Bermudagrass (*Cynodon dactylon*) hay diets by goats. J. L. Foster*¹, W. C. Ellis², J. P. Muir¹, and J. Sawyer², ¹Texas Agricultural Experiment Station, Stephenville, TX, ²Texas A&M University, College Station.

The objective of this study was to determine effects of two levels of *Strophostyles helvula* (Hel; 1.57% N, 47.57% NDF), *Strophostyles leiosperma* (Leo; 1.88% N, 49.0% NDF), or cotton seed meal (CSM; 8.10% N, 35.26% NDF) upon intake of coastal bermudagrass (CBG; 2.03% N, 68.12% NDF) hay and apparent digestibility of dietary OM (OMD), NDF (NDFD), and N (ND). Six Boer-Spanish goats (average weight 46.22 ± 3.99 Kg) were fed CBG plus fixed levels of Hel, Leo, or CSM at 0.34 or 0.68% of BW / d in a 6 by 6 Latin square design with 3 by 2 factorial arrangements of treatments. The CBG was fed ad libitum, and legumes / CSM fed in two equal daily feedings during a 7 d adjustment period and 7 d collection period in metabolism crates. Feces were collected every 24 h, weighed, sub-sampled, and frozen until dried at 100°C. Diet, legumes / CSM, and fecal samples were ground to pass a 1 mm screen in a Wiley mill and analyzed for OM, NDF and N. Nutrient intake and digestibilities were calculated and data analyzed

by GLM procedures of SAS. Interactions between source and amount were insignificant ($P = 0.16$). Intake of N was greater ($P < 0.01$) by goats fed CSM (111.3 ± 6.0 mg/kg BW) than by those fed Hel or Leo (each 74 ± 6.0 mg/kg BW). Otherwise N intake did not differ. Lack of differences due to inclusion of legumes was probably due to similarity in N content of legume and CBG ($P = 0.29$). Other than a trend for CSM to increase N intake, source and level of legume or CSM had no effect on intake of hay or digestibility of dietary NDF ($P > 0.05$). There was a tendency for improved digestibility of OM with the 0.68% supplementation level of all sources ($P = 0.06$; 56.5 vs. 63.3 ± 2.4 , 0.34 and 0.68% levels respectively). There was no benefit from feeding these legumes or CSM with CGB for these goats. Feeding these sources and levels of the two legumes or CSM did not impair intake or digestibility of CBG in this trial. Similarities in nutrient intake among treatments indicate that legumes and CSM replaced dietary CBG instead of increasing total intake.

Key Words: Goat, Legume, Supplement

M140 Effect of corn silage chop length on lactation performance of dairy cows on a commercial farm – a case study. T. D. Nennich^{*1}, J. H. Harrison¹, D. L. Davidson¹, J. Werkhoven², and A. Werkhoven², ¹Washington State University, Puyallup, ²Werkhoven Dairy, Monroe, WA.

The theoretical length of cut (TLC) of corn silage can affect the lactation performance of dairy cows. An on-farm case study was conducted to compare the differences in the lactation performance between cows fed corn silage that was chopped at 1.6 cm (SHORT) or 2.5 cm (LONG) TLC. Two pens of mid-lactation Holstein dairy cows (115 cows per pen) were assigned to one of two treatments in a 2 x 2 Latin square design. Diets were fed for two periods of 24 days each. The corn silages were stored in a bunker (SHORT TLC) or AgBag (LONG TLC) silo. Diets were formulated to contain 22.7% corn silage (DM basis) and were similar except for the corn silage. Cows were milked an equal number of times and averaged 3.2 milkings per day. Pen milk weights were recorded at each milking. Milk was sampled for composition analysis four times each period using the California DHIA in-line sampling kit. As expected, LONG diets resulted in a greater percentage of material on the top screen of the particle separator than SHORT diets. Milk production was numerically greater (0.4 kg/milking or 1.2 kg/d on a 3x milking schedule) for cows consuming SHORT diets. Dry matter intake and milk composition were similar for the two diets. Feeding SHORT corn silage diets resulted in numerically greater milk production (0.4 kg/milking) when corn silage was fed at a rate of approximately 23% of the dietary DM on this commercial dairy.

Treatment	Milk, kg/milking	DMI, kg/d	Milk fat, %	Milk protein, %
LONG	12.9	26.6	3.47	3.11
SHORT	13.3	26.5	3.50	3.09
SD	1.6	1.5	0.24	0.09

Key Words: Corn Silage, Dairy, Chop Length

M141 Peanut stover and bermudagrass hay for wethers on summer hardwood range in north central Texas. C. E. Packard^{*1,2}, J. P. Muir¹, R. Wittie², and R. Harp², ¹Texas Agriculture Experiment Station, Stephenville, TX, ²Tarleton State University, Central Texas.

Goats in the south-central United States raised on range often face a mid-summer forage quantity and quality deficit that may be mitigated by feeding inexpensive hay or stover. Peanut stover (10 % CP, 40% ADF) and Bermudagrass hay (12% CP, 33% ADF) were tested in north-central Texas as a 0.5% and 2.0% BW supplement/substitution on 20 kg Spanish X Boer goat wethers that browsed native hardwoods (8 head ha-1) and in a traditional feedlot, using a complete feed ration as a control. For 10 weeks from July to September in 2002 (216 mm rainfall) and in 2003 (354 mm rainfall) average daily gains (ADG) were measured and ADF and CP concentration of the primary browse species were determined. Goats receiving 0.5% BW bermudagrass in 2002 had greater ADG than those in the control and 0.5% BW peanut paddocks ($P < 0.1$). There were no differences ($P > 0.1$) in ADG among goats fed 2.0% BW of bermudagrass, and peanut stover or control animals in

2002. There were no differences ($P > 0.1$) among treatments in 2003. Goats fed concentrates in the drylot had greater ($P < 0.1$) ADG than goats eating either hay or stover ad libitum both years. There were no differences ($P > 0.1$) in carcass percent among animals in the range treatments. Control goats in the drylot had greater ($P < 0.05$) carcass percentages than animals fed either stover or hay (45, 37 and 31%, respectively). Supplementing goats on hardwood range with bermudagrass hay at 0.5% BW improved ADG only when low rainfall resulted in diminished browse (450-750 kg ha-1 at an average 11% CP and 29% ADF). Goats on woodland range at excessive stocking rates or on degraded range may also benefit from bermudagrass supplementation even during high rainfall years.

Key Words: Goat, Stover, Hay

M142 Forage intake, digestibility and gain by five beef breedtypes grazing rye-ryegrass-bermudagrass pasture and subsequent feedlot performance. T. D. A. Forbes^{*1}, F. M. Rouquette², R. D. Randel², and J. J. Cleere³, ¹Texas Agricultural Experiment Station, Uvalde, TS, ²Texas Agricultural Experiment Station, Overton, TX, ³Texas Cooperative Extension, Overton, TX.

An experiment was conducted using Angus (ANG), Bonsmara (BON), Brahman (BRM), Bonsmara x Angus (BA) and Braunvieh (BRV) steers grazing bermudagrass pastures overseeded with rye and ryegrass to determine forage intake and digestibility (DMD) using alkane markers, and to relate performance on pasture to subsequent feedlot performance. Ten animals of each breed were allotted to 5 pastures on Dec. 12. Animals were weighed at the start of the trial and at 28-d intervals for 121-d. On April 19, 5 animals of each breed were dosed with a controlled-release alkane capsule for the determination of intake and digestibility. From April 29, fecal samples were collected from each dosed animal on 5 consecutive days. Forage samples were collected daily for alkane determination, and forage mass was measured at the start and end of the intake trial. Forage and fecal samples were frozen and lyophilized prior to extraction of alkanes and determination by GC. Initial BW (kg) was 255 ± 7.3 , 183 ± 6.9 , 197 ± 6.9 , 256 ± 7.7 , and 213 ± 6.9 , respectively for ANG, BON, BRM, BA and BRV. The BON and BRM steers were 4 mo younger than the other breeds. Consequently, ADG and intakes are reported on a BW basis. Average daily gain on forage was highest ($P = 0.006$) in the BON steers (3.47 ± 0.275 g.kg LW⁻¹.d⁻¹) followed by BRV, ANG, BRM and BA (3.6 ± 0.26 , 3.5 ± 0.27 , 3.3 ± 0.26 and 2.8 ± 0.29 , respectively). Breed did not differ ($P = 0.50$) in DMI (5.2 ± 0.19 kg DM/d). Diet DMD tended ($P = 0.07$) to be higher in BRM and BRV and lowest in BA (0.69, 0.69, 0.68, 0.67, and 0.65 ± 1.07 for BRM, BRV, ANG, BON, and BA respectively). Feedlot ADG tended to be higher ($P = 0.09$) in the BON steers followed by ANG, BA, BVH, and BRM (5.5 ± 0.25 , 5.1 ± 0.26 , 5.1 ± 0.26 , 4.9 ± 0.23 and 4.5 ± 0.23 g.kg LW⁻¹.d⁻¹ respectively). Steers had higher ADG in the feedlot than on forage, but there was no correlation ($r = 0.117$, $P = 0.445$) between ADG on forage and ADG in the feedlot. These data suggest that BON steers, though smaller at the onset of the study, were able to grow efficiently, and that steers that perform well on forage can also perform satisfactorily in the feedlot.

Key Words: Alkanes, Steers, Grazing

M143 Soybean by-products for feeding grazing dairy cows. 1. Milk production and composition. R. F. Gregoret^{*1}, M. C. Gaggiotti¹, M. R. Gallardo¹, S. E. Valtorta², G. A. Conti¹, and C. Arakaki³, ¹Experimental Station Rafaela INTA, Ruta 34 km 227 Rafaela 2300 Santa Fe Argentina, ²National Research Council (CONICET) CC 22 Rafaela 2300 Santa Fe Argentina, ³CICV INTA CC 77 Castelar 1712 Buenos Aires Argentina.

The objective of this trial was to evaluate the effects of three soybean by-products on milk production and composition. Nine Holstein lactating cows, rumen fistulated (133 DIM) were used in a 3x3 Latin squares design replicated 3 times (28 days periods). The treatments were: SH = Soybean hulls, SM = Soybean meal (Solv-extd, 44) and SSR = Soybean seeds raw. The diets were iso-energy (1.6 Mcal NEL/kg DM), iso-protein (CP = 16%) and iso-fiber (NDF = 42%), and were formulated on a DM basis with alfalfa grazing (28%), a silage based partial mixed ration (PMR = 71%) and a mineral mix (1%). In SH soybean hulls represented 26% of total offered DM; in SM the soybean meal was 16%, while soybean seed represented 17% in SSR. Corn silage, on the

other hand, represented 13, 40 and 42 % in SH, SM and SSr, respectively. The PMR was fed to each cow in individual pens between the am and the pm milking. The rest of the day cows were sent to an alfalfa pasture, on daily strips. No differences were detected in DM intake. However, NDF consumption was higher in SH. There were no significant treatment effects on milk production and composition. The milk fat content was lower in SH ($P = 0.06$). Soybean hulls may be included in a high proportion (26 %) to feed grazing dairy cows in winter, to partially replace corn silage.

	Treatments ¹			SEM	T	Effects ² P<	
	SH	SM	SSr			P	T*P
DMI, kg/d	18.7	18.4	19.0	0.75	0.2731	0.0063	0.5486
NDF intake, kg/d	8.6 ^a	6.8 ^b	6.6 ^b	0.32	0.0007	0.0022	0.5542
Milk, kg/d	25.7	25.6	24.6	2.23	0.4438	0.8530	0.3719
3.5% FCM, kg/d	23.7	23.4	23.3	1.69	0.9889	0.4263	0.1403
Milk fat, %	3.09 ^b	3.37 ^{ab}	3.51 ^b	0.12	0.0594	0.0227	0.4212
Milk protein, %	3.49	3.49	3.40	0.12	0.2539	0.4539	0.9974
Fat yield, kg/d	0.83	0.82	0.82	0.06	0.9900	0.4300	0.1403
Protein yield, kg/d	0.93	0.86	0.79	0.05	0.2300	0.9600	0.1263

¹SH = Soybean hulls, SM = Soybean meal (Solv-extd, 44) and SSr = Soybean seeds raw ² T = treatment; P = period; T*P = interaction

Key Words: Soybean By-Products, Alfalfa Grazing Dairy Cows, Milk Production and Composition

M144 Soybean by-products for feeding grazing dairy cows. 2. Rumen fermentation. M. C. Gaggiotti^{1*}, C. Arakaki², M. R. Gallardo¹, R. F. Gregoret¹, S. E. Valtorta³, G. A. Conti¹, and O. Quaino¹, ¹Experimental Station Rafaela INTA Ruta 34 km 227 Rafaela 2300 Santa Fe Argentina, ²CICV INTA CC 77 Castelar 1712 Buenos Aires Argentina, ³National Research Council (CONICET) CC 22 Rafaela 2300 Santa Fe Argentina.

Nine ruminal fistulated Holstein cows in mid lactation, were used to evaluate soybean by-products on rumen fermentation, in a 3x3 Latin squares design replicated 3 times (28 days periods). The treatments were: SH= Soybean hulls, SM= Soybean meal (Solv-extd, 44%) and SSr= Soybean seeds raw. The diets were isoenergy, isoprotein and isofiber, and were formulated with alfalfa grazing, a silage based partial mixed ration (PMR) and a mineral mix. Soybean by-products represented 26, 16 and 17% of the DM diet, in SH, SM and SSr. Corn silage was 13, 40 and 42 %, respectively. The PMR was fed individually between am and pm milking, after which all cows were sent to an alfalfa pasture, on daily strips. Ruminal fluid samples were taken on days 23 and 25 during each period, at 0, 3, 6, 9, 12, 15, 18, 21 and 24 hours post-am PRM feeding to analyze pH, NH₃, total VFA, acetate (Ac), propionate (Pr) and butyrate concentrations. There were significant treatment effects on pH, total VFA and Ac:Pr ratio. In SH, pH and Ac:Pr ratio were lower, while total VFA were higher. Values for pH were never below 6.0 and the lowest Ac:Pr (1.75) was recorded 9 hours after the PRM feeding. There was a trend in all treatments for Ac:Pr to grow higher 6 hours after the beginning of grazing. Except for treatment by sampling time in Ac and Pr, no other significant interactions were detected. Soybean hulls can partially replace some winter diet ingredients, such as corn silage, with no evident negative effects.

	Treatments ¹			SEM	T	Effects ² P<		
	SH	SM	SSr			P	H	T*H
pH	6.19 ^b	6.46 ^a	6.53 ^a	0.04	<.001	<.001	<.001	0.597
NH ₃ , mg%	16.35	20.21	17.87	1.29	0.131	0.040	<.001	0.568
Total VFA, mM	150.47 ^a	139.04 ^{ab}	135.73 ^b	3.29	0.012	0.013	<.001	0.143
Acetate, mM	85.37	82.46	81.32	1.92	0.326	0.324	<.001	0.047
Propionate, mM	41.90	32.13	30.00	1.15	<.001	0.022	<.001	0.024
Butyrate, mM	15.45	15.21	15.29	0.40	0.912	<.001	<.001	0.449
Ac:Pr	2.09	2.66	2.79	0.07	<.001	0.187	<.001	0.006

¹SH = Soybean hulls, SM = Soybean meal (Solv-extd, 44) and SSr = Soybean seeds raw² T = treatment; P = period; H = sampling time; T*H = interaction

Key Words: Soybean By-Products, Alfalfa Grazing Dairy Cows, Rumen Fermentation

M145 Evaluating the use of indigestible neutral detergent fiber to predict dry matter intake of cattle fed high forage diets. R. Driskill*, J. R. Russell, K. Bormann, and W. J. Powers, Iowa State University, Ames.

The efficacy of NDF and indigestible NDF (iNDF) to predict voluntary feed consumption of steers fed a grass hay diet was determined in a digestion trial. Six Angus-Hereford growing steers (mean BW, 304 kg) were used in two 3 x 3 Latin square trials with a 7 d adjustment and 3 d collection periods. Three maturities of smooth bromegrass hay (pre-bloom, mid-bloom, mature) were fed at ad libitum levels individually in metabolism crates. Neutral detergent fiber was determined in an Ankom Fiber Analyzer (Ankom Technology Corp., Fairport, NY) with sodium sulfite and a heat-stable alpha-amylase on forage and fecal samples and the remaining residues after a 96 h fermentation of forage and fecal samples in ruminal fluid and a phosphate buffer in a Daisy¹¹ Incubator (Ankom Technology Corp., Fairport, NY). Concentrations of NDF and iNDF for the pre-bloom, mid-bloom, and mature hays were 56.1, 18.4; 67.6, 27.5; 70.1, 29.1% DM. Intakes and excretions of NDF and iNDF were 2.07±0.33, 0.92±0.21; 0.80±0.16, and 0.80±0.19 %BW and did not differ between steers. Regressions predicting NDF and iNDF excretion (%BW) from NDF and iNDF intakes (%BW) were $NDF_{fecal} = -0.11 + 0.50 NDF_{intake}$, $r^2 = 0.61$; $iNDF_{fecal} = -0.02 + 1.03 iNDF_{intake}$, $r^2 = 0.74$. Regressions predicting NDF and iNDF intake (%BW) from DMI (%BW) were $NDF_{intake} = 0.48 + 1.08 DMI$, $r^2 = 0.70$; and $iNDF_{intake} = 0.38 + 0.23 DMI$, $r^2 = 0.19$. Although iNDF excreted as %BW did not differ from iNDF consumed, large variations in iNDF intake as %BW suggests that iNDF is less accurate than NDF in predicting DMI of steers fed a single forage species.

Key Words: Indigestible Neutral Detergent Fiber, Forage Intake, Beef Cattle

M146 Visual assessment versus compressed sward heights as predictors of forage biomass in cool-season pastures. R. E. Vibart^{1*}, S. L. White-Bennett², J. T. Green², and S. P. Washburn¹, ¹Department of Animal Science, North Carolina State University, Raleigh, ²Department of Crop Science, North Carolina State University, Raleigh.

Two methods to predict pasture biomass for fescue-ladino clover and orchardgrass-ladino clover swards were studied. Visual assessment by an experienced observer was compared to compressed heights using a 0.2-m² acrylic plate meter that exerted 6.0 kg/m² pressure on the sward. Regression analyses were conducted for each method using clipped and dried plant material to ground level from 0.25-m² quadrats used as the referral method. Sampling included 150 observations for fescue on 38 d and 119 observations for orchardgrass on 30 d from 1995 to 1998. Estimates of biomass were sequential from least to most invasive: visual assessment; compressed sward height; and clipped biomass. Higher coefficients of determination (R^2) and lower errors of prediction (S_{xy}) for regressions indicated improved prediction of forage biomass. Regressed across sampling days and all observations, visual assessments ($R^2 = 0.69$ and 0.65, $S_{xy} = 685$ and 624 kg DM/ha for fescue, and orchardgrass, respectively) were more accurate in predicting forage biomass than were compressed sward heights ($R^2 = 0.37$ and 0.47, $S_{xy} = 998$ and 775 kg DM/ha for tall fescue and orchardgrass, respectively). Regression equations within sampling days were also more precise for visual assessment than for compressed sward heights for fescue ($R^2 = 0.94$ vs. 0.83 ± 0.03 ; $P < 0.01$; $S_{xy} = 297$ vs. 442 ± 48 ; $P < 0.05$; $n = 38$) and tended to differ for orchardgrass ($R^2 = 0.94$ vs. 0.89 ± 0.02 ; $P = 0.07$; $S_{xy} = 247$ vs. 321 ± 42 ; $P = 0.16$; $n = 30$). Compared to compressed sward heights, visual assessment had a higher percentage of predictions with $R^2 \geq 0.8$ (92 vs. 68% of 38, $P < 0.05$) for fescue and a numerically higher percentage (93 vs. 83% of 30) for orchardgrass. Reasons for lower accuracy using compressed sward heights were not clear. Indentations in soil surface, differences in composition, maturity, or ground cover could contribute to less precision using the plate meter. Visual assessment proved to be a simple and accurate method of predicting forage biomass in cool season pastures.

Key Words: Pasture Biomass

M147 Effect of swine manure application on winter wheat tissue growth and nitrogen, phosphorus, and potassium content. D. M. Sholly*, M. C. Walsh, B. C. Joern, A. L. Sutton, and B. T. Richert, *Purdue University, West Lafayette.*

Two studies were conducted to determine the effect of swine manure application on winter wheat growth and nutrient uptake. Manure was added to soil on an N basis at 224 and 325 kg plant available nitrogen (PAN)/hectare for Exp. 1 and 2, respectively. Soil was mixed with manure from pigs fed diets 1-4: 1) Standard (STD), 17.7% CP; 2) STD + 10% wheat bran (WB); 3) Low Nutrient Excretion diet (LNE) containing 13.9% CP, HAP corn, synthetic amino acids, and phytase; 4) LNE + 10% WB; 5) Negative Control (NC), 0 added PAN; and 6) Positive Control (PC), 325 kg PAN from $(\text{NH}_4)_2\text{SO}_4$ (Exp. 2 only). In Exp. 1 and 2, 20 and 30 winter wheat (CV. Patterson) seeds were sown/pot, respectively; 4 pots/trt. Exp. 1 wheat was defoliated at d 35, 63, and 91 for harvest 1 (H1), 2 (H2), and 3 (H3), respectively, and in Exp. 2 at d 28 and 56 for H1 and H2, respectively. Exp. 1, all manure trts increased H1, H3, root, total vegetative tissue (TVT), and total plant tissue (TPT) wt and N, P, and K tissue content compared to the NC ($P < .05$). STD manures increased H1 tissue wt by 12% (1.78 vs. 1.56 g; $P < .03$) and N and P content ($P < .001$), but decreased H2 tissue wt by 49% (0.31 vs. 0.61 g; $P < .0002$) and N, P, and K content ($P < .001$) compared to LNE manures. WB manures had no effect on plant growth or nutrient content ($P > .10$). Exp. 2, the PC increased H1, root, TVT, and TPT tissue wt ($P < .05$) and N content of H1, H2, TVT, and TPT and root K content ($P < .04$) compared to the NC. STD manures increased ($P < .03$) H2 tissue wt and N content by 19% and TVT tissue wt and N content by 10% compared to LNE manures. Manure trts increased H1 and TVT tissue wt ($P < .10$) and N ($P < .05$) content over the PC. Total P content of H1, H2, TVT, and TPT was increased ($P < .01$) by all manure trts over PC and STD manures were higher than LNE manures ($P < .01$). WB manures increased H1 P content by 11.5% compared to manures without WB (4.14 vs. 4.68 mg; $P < .01$). Manure trts yielded greater wheat growth than the NC and PC while also increasing plant tissue N and P content. Manure from pigs fed WB had minimal effects on wheat growth.

Key Words: Swine Manure, Wheat, Growth

M148 Effect of grass nonstructural carbohydrates on milk yield and composition and dry matter intake of dairy cattle. A. Buyserie*, P. French, and T. Downing, *Oregon State University, Corvallis.*

Previous research indicates increasing NSC content of grass forages increases utilization of degradable protein, microbial protein synthesis, and milk production. Dry matter intake also increases and N excretion decreases. Objectives were to identify differences in milk yield and composition, dry matter intake, and rumen fermentation between a high NSC and a lower NSC grass ingested as greenchop. Cool-season, perennial ryegrasses, one with a relatively high NSC content (HNSC) and one commonly grown in Oregon (CNSC) were selected. Grasses were planted fall, 2002 and fed spring, 2003. Twelve Holsteins and 2 Jerseys were blocked by milk yield and assigned at random to treatment. Individual intake and milk yield were collected twice daily for 21 days. Milk samples were collected for four consecutive milkings days 0, 7, and 21. Days 9 and 21, rumen samples were collected at 0, 1, 2, 3, 4, 6, 8, 10, and 12 hours relative to TMR feeding and analyzed for pH and ammonia. Grasses were cut, sampled, and offered *ad-lib* twice daily. TMR was offered for one hour twice daily. Data were analyzed with the MIXED procedure of SAS. For grass DMI, treatment by day interaction was significant ($P < .01$), with grass DMI being greater for HNSC during week 2. TMR DMI was greater for HNSC treatment ($P < .05$). Milk yield and yield of milk fat and milk protein were greater for HNSC treatment ($P < .05$). MUN and rumen ammonia did not differ between treatments ($P > .05$). Grass nutrient composition was different than expected. Grass NDF and ADF were similar ($P > .05$), HNSC was higher in CP ($P < .01$) and lower in NSC ($P < .05$). In this study, milk and component yields for HNSC were greater than CNSC treatment, however effects appear to be caused by factor(s) other than grass NSC.

Key Words: Grass Forages, Nonstructural Carbohydrates, Protein Utilization

M149 Number of experimental units required to detect differences in grazing time. D. H. Seman*¹, J. A. Stuedemann¹, and L. W. Douglass², ¹USDA-ARS, *Watkinsville, GA*, ²University of Maryland, *College Park.*

The objective of this study was to determine the number of cattle necessary to detect differences in time spent grazing by steers on E+ tall fescue. In each of two years, 12 yearling Angus steers grazed tall fescue pastures, three pastures were highly infested (64%) (*Neotyphodium coenophialum*) KY-31 fescue, while three had low infestation rates (32%). One steer on each pasture received an experimental drug to overcome effects of endophyte infection and one received a placebo on Monday, Wednesday, and Friday during the three-week (1988) and four-week (1989) study. All 12 steers were fitted with vibracorders to record continuous grazing behavior during the studies. Statistical analyses of time spent grazing/h was conducted by the Mixed Procedure of SAS with day as a repeated measure and pasture considered a random effect. The Mixed Procedure calculated eight standard errors, one for each endophyte, drug and year combination and resulted in a range of values when estimating the number of experimental units. It would take from 14 to 115 steers/treatment to detect a 5% difference in minutes spent grazing/h $\alpha = .05$. Up to 30 steers/treatment would be needed to detect a 10% difference, 7 to 15 to detect a 15% difference, 4 to 9 to detect a 20% difference, 4 to 6 for a 25% difference, and 2 to 5 to detect a 30% difference. These analyses point out the importance of calculating an accurate standard error with which to estimate experimental units. Box-Jenkins ARIMA time series analysis showed that minutes spent grazing/h differed ($P < .05$) between days when steers were gathered and given drug and days when steers were left alone in 1988 and during week 1 in 1989. Grazing behavior at any given time of the day was correlated with the previous one or two hours. A significant 24-h seasonal component showed that grazing behavior repeated ($P < .01$) at the same time on subsequent days. Results suggest that it may not be necessary to monitor grazing behavior continuously day after day to obtain a representative sample. Data on days when normal grazing behavior is disrupted, e.g., by gathering steers, may not be representative of time spent grazing throughout a given collection period.

Key Words: Cattle, Grazing Behavior

M150 Relationship of rate of appearance of vaccenic acid and pH during in vitro biohydrogenation of linolenic acid from alfalfa hay. C. V. D. M. Ribeiro* and M. L. Eastridge, *The Ohio State University, Columbus.*

Using an in vitro system, approximately 0.5 g of DM from alfalfa hay (92%) and sucrose (8%) was incubated with rumen fluid using two different buffers: one at average pH at 6.3 (HpH buffer, 100:0 $\text{NaHCO}_3/\text{NaCl}$, wt/wt) and the other at 5.8 (LpH buffer, 50:50 $\text{NaHCO}_3/\text{NaCl}$, wt/wt). Samples were incubated for 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 h. At each time point, the pH was measured and the tubes were immediately put in ice and stored at -20°C until freeze-drying. Fatty acids (FA) were methylated with sodium methoxide (10 min at 50°C) followed by HCl in methanol (10 min at 80°C). Rates (mg/ml/h) for individual FA were determined using PROC NLIN of SAS (2002). The pattern of linolenic acid disappearance was similar for both pH. The amount of linolenic acid remaining was high for the LpH buffer until 7 h. After 7 h, the amounts were the same for both buffers. A similar pattern for the amounts of vaccenic acid (VA) was observed from 0 to 6 hours. The amount of VA formed from 0 to 6 h was the same, peaked at 2 h and decreased until 6 h for both buffers. After 6 h, the rates of VA appearance were 0.00502 and -0.000783 for the HpH and LpH buffers, respectively. The amount of VA from 6 to 12 h of incubation changed very little for the LpH buffer. The amount of stearic acid was always higher for the HpH buffer. The rates of stearic acid appearance from 0 to 6 h were 0.00214 and 0.00103 for HpH and LpH buffers, respectively. Disappearance of linolenic acid from alfalfa hay was slightly affected by a low pH, with no difference after 7 h. Based on linolenic acid disappearance, the final reduction step of biohydrogenation appears to be more susceptible to the low pH than the steps prior to the formation of VA.

Key Words: Vaccenic Acid, Alfalfa, Biohydrogenation

M151 Comparison of biohydrogenation of fatty acids in lyophilized forage and air dried forage with sucrose additions. C. V. D. M. Ribeiro* and M. L. Eastridge, *The Ohio State University, Columbus.*

Grazing animals produce a higher percentage of conjugated linoleic acid (CLA) in milk fat compared to animals fed TMR, and most of the CLA is synthesized in the animal from vaccenic acid (VA). It has been proposed that this higher amount of CLA in milk fat is due to higher concentrations of soluble sugars in fresh plants. To observe the effect of sucrose on biohydrogenation (BH) and formation of trans-18:1 fatty acids (FA), four continuous culture fermenters were used in a 4 X 4 Latin square. Each period consisted of 7 d of adaptation and 3 d of sample collection. Fresh alfalfa samples (prebloom to early bloom) were obtained from a greenhouse at the Ohio Agricultural Research and Development Center (Wooster, OH). Samples were harvested randomly and immersed immediately in liquid nitrogen using a metal grid. Samples were freeze-dried, ground at 1mm, and stored at -20 °C. Alfalfa hay was purchased and contained 38% NDF and 21% CP. The treatments were: 1) fresh alfalfa, 2) alfalfa hay, 3) 96% alfalfa hay and 4% sucrose, and 4) 92% alfalfa hay and 8 % sucrose. The FA analyses were performed on the effluent samples. The FA were methylated with sodium methoxide (10 min at 50 °C) followed by HCl in methanol (10 min at 80 °C). Data were analyzed by the PROC MIXED procedure of SAS (2002). Total BH and BH of linolenic acid were higher ($P < 0.05$) for fresh alfalfa compared to alfalfa hay with no sucrose. The BH of linoleic and linolenic acid decreased linearly with higher sucrose supplementation. Total BH decreased linearly ($P < 0.05$) for alfalfa hay with higher sucrose supplementation. It seems that sucrose impaired total BH. Fresh alfalfa had a more complete BH with lower levels of trans-18:1 FA in the effluent. Although not different statistically, percentage of VA in the effluent was numerically lower ($P = 0.13$) for fresh alfalfa. Percentage of trans-10 18:1 also tended to be lower ($P < 0.10$) for fresh alfalfa. We concluded that sucrose itself may not be responsible for the higher VA observed in milk of grazing cows. We speculate that other factors, such as pH and soluble proteins, may also be involved.

Key Words: Biohydrogenation, Alfalfa, Continuous Culture

M152 Effects of level of protein supplementation on performance of crossbred calves grazing Tifton 85 bermudagrass. S. A. Woods*¹, F. M. Rouquette, Jr.², G. E. Carstens¹, T. D. A. Forbes³, and W. C. Ellis¹, ¹Texas Agricultural Experiment Station, College Station, TX, ²Texas Agricultural Experiment Station, Overton, TX, ³Texas Agricultural Experiment Station, Uvalde, TX.

The high protein requirement of growing crossbred calves fuels the search for grazing management programs that effectively meet their nutritional needs. The objective of this study was to determine the effects of level of protein supplementation (PS) on performance of crossbred calves grazing Tifton 85 bermudagrass (TIF85). Weaned Simmental-sired, 25% Angus, 25% Brahman steers and heifers ($n = 59$; mean BW = 345.4 ± 4.1 kg) were blocked by BW within sex, and randomly assigned to one of four treatment groups (three pasture replicates/trt): (1) pasture (PAS), (2) PAS + 0.2% BW of a 2:1 SBM:corn PS containing salt, dicalcium phosphate, magnesium oxide, and Rumensin 80, fed daily (.2BW), (3) PAS + 0.4% BW PS (.4BW), or (4) PAS + 0.8% BW PS (.8BW). The PAS calves were provided free choice access to a mineral premix without Rumensin 80. TIF85 pasture plots (0.68 ha) were stocked at 8.6 hd/ha and grazed for 90 d during the summer of 2003. Calves were weighed at the start of the study and 28 d thereafter. ADG during the first 56 d of the study increased ($P < 0.001$) in a linear manner as the level of PS increased (0.93, 1.03, 1.16 and 1.27 ± 0.05 kg/hd/d for PAS, .2BW, .4BW and .8BW, respectively). Overall ADG during the 90 d study also increased ($P < 0.001$) in a linear manner (0.70, 0.81, 0.92 and 1.11 ± 0.04 kg/hd/d for PAS, .2BW, .4BW and .8BW, respectively). Overall, calves receiving .8BW treatment gained 37 kg more than those grazing PAS. Using pasture plot as experimental unit, BW gain per ha increased ($P < 0.001$) in a linear manner as level of PS increased (546, 634, 716 and 864 ± 32.5 kg/ha for PAS, .2BW, .4BW and .8BW, respectively). Additional calf gain was 0.11, 0.21 and 0.40 kg/d for .2BW, .4BW and .8BW, respectively. Efficiency of supplementation, expressed as PS:extra gain ratio, was 6.83, 6.85 and 7.24 for .2BW, .4BW and .8BW treatments, respectively. In this study, level of

PS up to 0.8% of BW was effectively used to increase the performance of calves grazing Tifton 85 bermudagrass.

Key Words: Tifton 85 bermudagrass, Protein Supplementation, Stocker

M153 Forage quality of perennial grass as influenced by stubble height. J. H. Cherney* and D. J. R. Cherney*, *Cornell University, Ithaca, NY.*

Timing of spring grass harvest is critical to obtaining optimum forage quality, and the harvest window is narrow. We studied the feasibility of harvesting grass at a higher stubble height to improve forage quality. Rival reed canarygrass, Okay orchardgrass, and Select tall fescue were fertilized with 0, 112 and 224 kg N fertilizer/ha at spring greenup and sampled in late May or early June in 2001, 2002 and 2003. Four replicates at each of two sites were sampled, a fertile site in Ithaca, NY and a more marginal high elevation site in Dryden, NY. Samples were cut at a 10-cm stubble height and sectioned into 5-cm increments using a paper cutter. Samples were dried, ground and analyzed for forage quality parameters. The study was analyzed as a randomized complete block with a split plot arrangement of treatments. Main plots were grass species; subplots were nitrogen fertilizer treatments. Dry matter yield per cm of stubble height above a 10-cm cut was highly positively correlated with total stand yield ($r^2 = 0.88$; $P < 0.01$), ranging from 36 to 108 kg DM per cm of vertical growth. Percent of total yield per cm of lower canopy varied with the height of the stand. For grass fertilized with 112 kg of N, CP increased by 0.25 percentage units ($r^2 = 0.74$; $P < 0.01$) and NDF decreased by 0.30 percentage units ($r^2 = -0.85$; $P < 0.01$) per cm of vertical height above a 10-cm stubble. In vitro digestibility increased by 0.29 percentage units ($r^2 = 0.74$; $P < 0.01$) and fiber digestibility increased by 0.30 percentage units ($r^2 = 0.59$; $P < 0.01$) per cm of vertical height above a 10-cm stubble. Forage quality of the total stand increased in CP by 0.15 percentage units and decreased in NDF by 0.13 percentage units per cm of additional stubble left in the field, which is inconsequential.

Key Words: Forage Quality, Stubble Height, Grass

M154 Evaluation of tall fescue, soybean hulls and ionophores in vitro. L. A. Briggs*, J. C. Waller, H. M. Blalock, and C. J. Richards, *The University of Tennessee, Knoxville.*

Combinations of endophyte (*Neotyphodium ceonophialum*) infected (E+) Kentucky-31 tall fescue (*Festuca arundinacea* Schreb.) and soybean hull (SH) were incubated *in vitro* with ionophores to determine VFA and gas production, DM disappearance, and NH₃-N release. Substrates consisted of tall fescue:SH ratios of 100:0, 85:15, 70:30, 55:45, and 0:100. Substrates were incubated with no ionophore, Rumensin[®], or Bovatec[®] in a 5 x 3 factorial design with three replicate runs. Both ionophores were mixed at a rate to provide 33 mg of active ingredient per kg of substrate. Substrates (0.5 g; DM) were sealed in F57 bags (Ankom, Inc., Macedon, NY) and incubated in 100 mL of McDougalls buffer:rumen fluid inoculum (4:1). Gas pressure sensors were used to continuously monitor changes in pressure over a 72 h period. At the end of the incubation, the F57 bags were removed, washed with hot water, and dried for determination of DM disappearance. A sample of the remaining inoculum was retained for VFA and NH₃-N analysis. Ionophore addition did not affect DM disappearance, gas production, or VFA and NH₃-N concentrations. DM disappearance increased linearly ($P < 0.05$) with SH concentrations from 0 to 45%. There was a tendency ($P < 0.08$) for the rate of gas production to respond in a quadratic manner as SH increased from 0 to 45%. Gas production per unit of substrate disappearance did not differ ($P > 0.48$). Acetate and total VFA concentrations increased linearly ($P < 0.05$) while propionate concentrations tended ($P < 0.08$) to increase with SH concentrations from 0 to 45%. Incubation of 100% SH resulted in the greatest valerate and isovalerate concentrations. Concentrations of NH₃-N decreased as SH concentrations increased from 0 to 45%. Substitution of up to 45% soybean hulls in fescue-based diets resulted in greater substrate digestion with increased energy release and decreased NH₃-N release.

Key Words: Fescue, In Vitro, Digestion

M155 Effects of stocking method and rate on seasonal cow-calf performance and forage quality. W. E. Wyatt^{*1}, B. C. Venuto², J. M. Gillespie³, and D. C. Blouin³, ¹Louisiana State University Agricultural Center, Jenerette, ²Grazing Lands Research Laboratory, USDA, ARS, El Reno, OK, ³Louisiana State University Agricultural Center, Baton Rouge.

Effects of stocking method and rate on cow-calf performance and forage quality were evaluated by the following treatments: continuous-stocked pastures at a low (1.2; CL), medium (2.0; CM), and high rate (2.7 cows per ha; CH) and rotational-stocked pasture (8 paddocks) at a high rate (2.7 cows per ha; RH). Brangus cows and calves were stocked on replicated treatment pastures on a year-around basis for three years. Cows were weighed prior to calving (January), prior to breeding (April), at weaning (October), and again the following January. Spring-born calves were weighed at birth, in April, and at weaning. Seasons corresponding to weigh periods were February-April (ES), May-June (LS), and July-October (S). The LS period represented a transition from annual ryegrass (principal forage in ES) to common bermudagrass-dallisgrass (principal forages in S) forage bases. Statistical analyses were conducted using a generalized linear mixed-model procedure. Cow weight gains and calf ADG were similar ($P > .2$) among treatments in ES. In LS, CL cows lost less weight than CM ($P < .01$; -33 vs -48 kg), and CH cows lost less weight than RH ($P < .01$; -39 vs -54 kg). Calf ADG in LS was greater for CL than for CM ($P < .01$; .93 vs .8 kg) and was greater for CM than for CH (.72 kg; $P < .01$), but similar ($P = .54$) between CH and RH calves. In LS, forage CP (12.7 vs 11.1 %) and IVTD (60.9 vs 57.3 %) were greater for CH than for RH ($P < .05$). In S, CM cows gained more weight than CL cows ($P < .05$; 34 vs 28 kg) and than CH cows ($P < .01$; 34 vs 18 kg) and CH cows gained more weight than RH cows ($P < .01$; 18 vs 11 kg). In S, CL and CM calves had similar ADG ($P = .76$; .98 and .96 kg), but CM was greater than CH (.78 kg; $P < .01$) and CH was greater than RH (.7 kg; $P < .05$). In S, forage CP was greater for CH than for RH ($P < .01$; 13.3 vs 11.7 %). Selected forage IVTD tended ($P < .1$) to be higher for CM than for CH. Stocking rate and method affected cow-calf performance and forage quality in late-spring and summer (warm-season, perennial grasses), but had less impact during the early-spring (cool-season, perennial grasses).

Key Words: Stocking Rate, Stocking Method, Cow-Calf

M156 Evaluation of ensiled sorghums with and without condensed tannins as feeds for ruminants. H. Carneiro^{*1}, P. B. Arcuri¹, J. A. Rodrigues², F. S. Sobrinho¹, S. S. Brum¹, and M. Villalquira³, ¹Embrapa Gado de Leite Juiz de Fora, MG, Brazil, ²Embrapa Milho e Sorgo Sete Lagoas, MG, Brazil, ³E (Kika) de la Garza American Institute for Goat Research, Langston University, Langston, OK.

Historically, there is a believe that condensed tannins (CT) are responsible for low digestibility of plant material and are recognized as anti-nutritional factors in diets of monogastric animals. High CT concentrations can reduce the absorption of protein from the small intestine of monogastric. However, in ruminant diets low concentrations (1-3% DM) can be beneficial by reducing ruminal degradation of forage protein, which outweigh any detrimental effects of reduced protein availability in the small intestine. A total of 10 Sorghum cultivars (lines CMSXS114 Tannin (T) and CMSXS165 Without Tannin (WT), Hybrids 9953101(T), 9953130(T), BR601 (WT), BR701 (T), BR700 (T), and AG2005 (WT), and Varieties BR 501(WT), and BR506 (WT)) with 8 replications were ensiled in PVC silos of 3 kg per silo for 60 d and then analyzed for CT, (colorimetric analysis by the butanol-HCl method) CP, NDF, ADF, and in situ and in vitro (4, 24, and 48 h) digestibilities. Condensed tannins from quebracho were purified using affinity chromatography with sephadex LH-20 and used as a standard. Low concentration of CT have been defined as 10 g/kg DM or less and medium as 10 to 50 g/kg DM or more. Hybrid BR701 had the highest concentration of CT among the sorghums ($P < 0.05$) with 7 g/kg DM. Differences among sorghums were not detected for NDF ($P = 0.10$), ADF ($P = 0.10$), or in vitro digestibility ($P = 0.09$). The highest CP content was noted for line CMSXS165 (9.74 g/kg; $P < 0.05$). Concentrations of CP in CMSXS114 (8.32 g/kg), BR 700 (7.44 g/kg), and BR701 (8.05 g/kg) were above the overall mean (7.4 g/kg). The Hybrid BR700 showed the fastest rate of ruminal degradation of these 3 in the 4 h ($P < 0.05$), followed by CMSXS114 and CMSXS165. The two latter were sorghums isogenic lines that differ only in CT concentration. It was concluded that digestibility was not affected by CT level; however, relative CT concentrations were low. Therefore, we would do not anticipate significant effects of CT content on DM intake, digestibilities, or performance in cattle fed these sorghum silages.

Key Words: Silage, Tannin, Ruminant Nutrition

Ruminant Nutrition I

M157 Effect of increasing sodium bicarbonate proportion in high concentrate diets on ruminal fermentation in finishing beef heifers. L. González^{*}, A. Ferret, S. Calsamiglia, and X. Manteca, *Universitat Autònoma de Barcelona Edifici V, Campus UAB, Bellaterra, Barcelona, Spain.*

Four rumen fistulated Holstein heifers (264 ± 12 kg initial BW) were used in a 4 x 4 Latin square design to determine the effect of increasing levels of sodium bicarbonate (0, 1, 2 and 4 %, on DM basis) on ruminal fermentation. The main ingredients of the concentrate were: 33% barley grain, 32% corn grain, 16% tapioca and 10% soybean meal. Heifers were allowed to consume concentrate and barley straw on an ad libitum basis, which resulted in a mean of 12 to 88 forage to concentrate ratio. Linear, quadratic and cubic effects were analyzed with the Type 1 analysis of variance of the PROC MIXED procedure of SAS with animal and period considered random effects. Mean ruminal pH and total area under the pH curve tended to increase linearly ($P < 0.15$) with increasing buffer proportion. The lowest pH (5.65 ± 0.09) was similar across treatments. Hours in which pH was below 5.8 tended ($P = 0.10$) to a quadratic effect, the values being 12.6, 3.6, 3.2 and 4.7 h, for 0, 1, 2 and 4 % of sodium bicarbonate, respectively. Average ammonia nitrogen concentration was not affected by treatment (2.44 ± 0.87 mgN/100mL). Total VFA concentration was not affected by treatment (143 ± 12 mM). Molar proportion of propionate decreased linearly ($P < 0.05$) and acetate tended to increase linearly ($P < 0.10$) with increasing buffer proportion in the diet. Acetate to propionate ratio, molar percentage of butyrate and branch-chained VFA increased linearly ($P < 0.05$) as sodium bicarbonate proportion increased in the diet. Valerate was not affected by treatment. Data suggests that increasing sodium bicarbonate beyond 1% does not bring any further benefits to overall pH and ruminal fermentation conditions. Factors other than sodium

bicarbonate proportion used as a buffer must play a role in the control of the effects of high concentrate diets on ruminal fermentation.

Key Words: Beef Heifers, Rumen Fermentation, Sodium Bicarbonate

M158 Effects of sodium bicarbonate on ruminal pH and feed intake in feedlot cattle. L. Paton^{*1}, M.A.G. von Keyserlingk¹, K. A. Beauchemin², and D. M. Veira³, ¹University of British Columbia Animal Welfare Program, University of British Columbia, Vancouver, British Columbia, Canada, ²Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada, ³Agriculture and Agri-Food Canada, Kamloops, British Columbia, Canada.

The objective of this study was to determine whether sodium bicarbonate (NaHCO₃) could reduce the risk of acidosis in cattle receiving high concentrate diets. Ruminally cannulated Jersey steers (n=3) and Holstein cows (n=3), previously adapted to a high concentrate diet, were used in a repeated 3x3 Latin square to study the effects of NaHCO₃ on daily feed intake and ruminal pH. Cattle were provided ad libitum access to a control diet of steam-rolled barley, barley silage, and a protein-mineral supplement at 80, 12 and 8% (DM basis), respectively. Treatments were control, control plus free choice NaHCO₃ mixture and control supplemented with 0.7% NaHCO₃ (% DM basis). The free choice NaHCO₃ mixture was offered as 30% dried molasses and 70% NaHCO₃ based on a previous palatability trial. Periods consisted of 11 d adaptation and 3 d of continuous ruminal pH measurements using indwelling electrodes. Daily DMI (mean ± SE) did not differ between the control (7.95 ± 1.34 kg/d) and free choice NaHCO₃ (8.27 ± 0.86 kg/d) ($P = 0.67$) or the NaHCO₃ supplemented diet (7.94 ± 0.48 kg/d) ($P = 0.99$). Mean lowest feed intake for the control diet, free choice NaHCO₃ diet and 0.7% NaHCO₃ supplemented diet were 2.98 kg/d, 5.51 kg/d and 6.89 kg/d, respectively. Considerable variation in daily free choice

NaHCO₃ intake (104.6 ± 45.6 g/d) was also observed. Control mean ruminal pH (5.81 ± 0.09) did not differ from the free choice NaHCO₃ diet (5.88 ± 0.08) ($P = 0.43$) or the NaHCO₃ supplemented diet (5.92 ± 0.10) ($P = 0.39$). Variation in control ruminal pH did not differ from the free choice NaHCO₃ ($P = 0.43$) or the NaHCO₃ supplemented diet ($P = 0.47$). These results suggest that supplementing a feedlot diet with either 0.7% NaHCO₃ as a component of the diet or free choice has no effect on total daily DMI or daily mean ruminal pH when compared to the control diet.

Key Words: Acidosis, Feedlot Cattle, Rumen pH

M159 Effects of monensin and different dose levels of essential oils on feed intake, growth performance and feed efficiency of beef cattle. C. Benchaar^{*1,2}, E. Charmley³, and J. Duynisveld³, ¹Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada, ²Nova Scotia Agricultural College, Truro, Nova Scotia, Canada, ³Crop and Livestock Research Centre, Agriculture and Agri-Food Canada, Nappan, Nova Scotia, Canada.

The objective of this study was to investigate the effects of dietary addition of monensin (Rumensin[®]; MO) or different dose levels of a commercial mixture of essential oils (Vertan[®]; EO) on feed intake, growth performance and feed efficiency of beef cattle. The mixture of EO consisted of thymol, eugenol, vanillin and limonene. Twenty steers and twenty heifers (Angus × Herford, initial BW = 369 ± 29 kg) were assigned to ten blocks of four cattle according to BW and fed for *ad libitum* intake a TMR comprising 75% grass/legume silage and 25% of rolled barley (dry matter basis). Within each block, cattle were randomly assigned to one of four experimental treatments; unsupplemented TMR (Control, CO) or TMR supplemented with MO (220 mg/d) or EO (2 and 4 g/d). During the experiment (98 and 82 days duration for the steers and heifers; respectively), feed intake was recorded daily and animals were weighed at the start and end of the trial and at two week intervals during the trial. Data were analyzed as a randomized block design using the PROC MIXED procedure of SAS. Specific prior contrasts were used to test differences between CO and diets supplemented with MO and EO, and to determine the linear or quadratic response to EO dose level. Dry matter intake (DMI) was not affected by the addition of EO (8.6 kg/d; $P > 0.05$). However, DMI was 10 % lower ($P < 0.01$) for cattle fed MO compared to those fed CO. Average daily gain (ADG) was similar between cattle fed CO and those consuming supplemented diets (1.2 kg/d; $P > 0.05$). Feed efficiency (DMI to ADG ratio) was not different between cattle fed CO and those receiving MO and EO treatments (7.0; $P > 0.05$). However, a quadratic effect of EO dose level was observed ($P < 0.05$). Feed efficiency was decreased by the addition of 2 g of EO/d (6.6 vs 7.0), where as it was increased when the diet was supplemented with 4 g of EO/d (7.8 vs. 7.0). Results from this study suggest that further work is required to determine the optimum level of EO supplementation to improve feed efficiency in beef cattle.

Key Words: Monensin, Essential Oils, Beef Performance

M160 Monensin or decoquinat in high concentrate diets fed to Santa Ines lambs. I. Susin^{*1,2}, C. Q. Mendes^{1,2}, A. V. Pires^{1,2}, and I. U. Packer^{1,2}, ¹University of São Paulo, ²ESALQ.

Feedlot lamb meat production has increased in Brazil. However, feedlot lambs are more susceptible to coccidiosis occurrence. Addition of an anticoccidial drug to the diet may improve lamb performance. Two trials were performed to evaluate the effects of using decoquinat or monensin on feedlot lamb performance. In each experiment, animals were assigned to a complete randomized block design according to body weight and age at beginning of the trial. Trial 1: Forty-two Santa Ines ram lambs (initial BW 19.2 ± 0.1 kg and 81 ± 1.4 d old) were fed a 95% concentrate and 5% raw sugarcane bagasse diet for 56 days. To the control diet (CON) was added either decoquinat (DEC, 17 mg/kg DM) or sodium monensin (MON, 25 mg/kg DM). Both DEC and MON were effective in reducing oocysts per gram of feces as compared to the control diet ($P < 0.001$). However, there were no differences on performance among treatments. Average daily gain (ADG), dry matter intake (DMI), feed conversion (FC) and hot carcass yield (HCY) were 270, 287 and 271 g/day; 0.94, 0.97 and 0.95 kg/day; 3.48, 3.43 and 3.51 kg DMI/kg gain and 46.8%, 47% and 47.2% for treatments CON, DEC and MON, respectively. Trial 2: Forty-eight Santa Ines ewe lambs (initial BW 18.4 ± 0.1 kg and 89 ± 2.5 d old) were fed the same diet of Trial 1 for 56 days

(Phase 1). In Phase 2, the same ewe lambs were fed a 70% concentrate and 30% coarcross hay diet during an additional 56 day period. There were no differences among treatments in Phase 1 for ADG, DMI and FC (186, 199 and 183 g/day; 0.77, 0.81 and 0.74 kg/day; 4.2, 4.1 and 4.1 kg DMI/kg gain for treatments CON, DEC and MON, respectively). In Phase 2, however, ewe lambs on MON treatment had a higher ADG and better FC ($P = 0.03$). There was no difference on DMI, ADG, FC and DMI in Phase 2 were 121, 121 and 149 g/day; 8.7, 8.8 and 7.4 kg DMI/kg gain; 1.05, 1.07 and 1.1 kg/d for CON, DEC and MON, respectively. Adding monensin to a 70:30 (concentrate:roughage ratio) diet for ewe lambs improved ADG and FC 19 and 15%, respectively. The addition of monensin or decoquinat in feedlot lamb diets control oocyst discharge; monensin also improves ADG and feed efficiency in older ewe lambs.

Key Words: Hair Sheep, Ionophore, Performance

M161 Effects of yeast culture in barley-based backgrounding and finishing diets for cattle on health, growth performance, and fecal *Escherichia coli* populations. Y. Wang^{*1}, T. A. McAllister¹, S. J. Bach¹, D. J. Gibb¹, and I. Yoon², ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, Canada, ²Diamond V Mills, Inc., Cedar Rapids, IA.

The effects of a naturally fermented *Saccharomyces cerevisiae* feed additive (Diamond V XP#8482 Yeast Culture, YC) on health, growth performance and fecal *Escherichia coli* were assessed using 390 newly weaned British × Charolais crossbred steers (292.5 ± 1.23 kg initial BW) in a completely randomized study that included backgrounding (BKGD) and finishing (FNSH) periods. Barley silage/barley grain-based feedlot diets were fed as is (control) or amended with YC to provide 56.7 g/d to each steer for the first 28 d, followed by 28.3 g/d to the end of BKGD (treatment YC-B) or through to the end of FNSH (treatment YC-BF). Feed intake, ADG, and gain/feed were determined on a per-pen basis ($n = 10$) at 4-wk intervals. Fecal samples collected from each steer ($n = 130$) were analyzed for total *E. coli* counts (at end of BKGD) and presence of *E. coli* O157:H7 (and end of BKGD and end of FNSH). Carcass weight, fat cover, longissimus area, and dressing percentage were recorded at harvest (commercial abattoir). Growth rates averaged 1.26 kg/d during BKGD and 1.32 kg/d during FNSH. Feeding YC did not affect ($P > 0.05$) DMI, ADG or gain efficiency of the steers during BKGD or FNSH, nor were treatment effects on carcass traits observed ($P > 0.05$). Prevalence of *E. coli* O157:H7 was low. At the end of BKGD, this pathogen was detected in only four steers from a single YC-BF pen. At the end of FNSH, *E. coli* O157:H7 was present in fecal samples from two control steers (in 1 pen) and 13 YC-B steers (in 3 pens), but none in the YC-BF group. Total fecal *E. coli* counts at the end of BKGD were similar across treatments. Three deaths due to bloat were recorded in the control group, plus removal of one YC-B steer. There were no fatalities due to bloat in the YC-BF group. In the present study, YC did not affect health, growth performance or fecal shedding of *E. coli* O157:H7 by feedlot cattle.

Key Words: *E. coli* O157:H7, Feedlot Cattle, Yeast Culture

M162 Effects of alcohol-fermented feedstuff with live yeast on growth characteristics, serum metabolites, and meat compositions in Korean native bulls. S. Jong Suh^{*}, P. Byung Ki, and H. Byong Ju, Department of Animal Resources Science, Kangwon National University, Chunchon, Korea.

The effects of alcohol-fermented feedstuff with live yeast (AFF) on average daily gain, serum metabolites, and meat compositions were investigated using forty Korean native bulls (initial wt: 255.9, final wt: 649.2). The AFF (cracked corn:cracked oat:water:molasses:live yeast=48.48%:12.12%:30.30%:6.07%:3.03%) was fermented anaerobically in an incubator at 30° for 48 hours. Experimental diets were commercial feed, AFF, and rice straw. The feeding of rice straw was *ad libitum* feeding in control and treatment. Bulls were individually fed for 14 months. The experiment was composed of two groups: control (100% of commercial feed), treatment (50% of commercial feed and 50% of AFF). Average daily gain (ADG) was higher in treatment than in control ($P < 0.05$; 1.06 vs 0.89). Total gain, total dry matter intake (TDMI), and feed conversion were not different between treatment and control. The blood cholesterol and triglyceride concentration were higher in treatment than in control, but the blood urea nitrogen (BUN) concentration of treatment was lower than that of control during growing (200–400)

period. The blood glucose, cholesterol, and triglyceride concentration were high in treatment, compared to control ($P < 0.05$) during finishing (400–700) period. The ether extract content of longissimus dorsi (LD) muscles of treatment was higher than that of control ($P < 0.05$). The essential and nonessential amino acid content of LD muscles were similar between control and treatment. The saturated fatty acid content of LD muscles was lower in treatment than in control, but the unsaturated fatty acid content of LD muscles was high in treatment, compared to control. The oleic acid content of LD muscles was significantly higher in treatment than in control ($P < 0.05$). Consequently, the increase of ADG and unsaturated fatty acid content was observed in treatment according to feeding the AFF. Therefore, it is expected that the AFF will be effective to improve growth performance and meat quality in Korean native bulls.

Key Words: Alcohol-Fermented Feedstuff with Live Yeast, Korean Native Bulls, Meat Composition

M163 Rate and extent of *in situ* DM disappearance of feedstuffs in cows fed different strains of yeast. J. C. Silva* and L. W. Greene, *Texas Agricultural Experiment Station, Amarillo, TX.*

An *in situ* experiment was conducted to determine rate and extent of DM disappearance (DMD) of corn grain (CG), sorghum grain (SG), alfalfa hay (AH) and brown mid-rib forage sorghum silage (SS) in the presence of different strains of yeast. Four mature rumen cannulated non-lactating cows were fed a control diet (C), or C diet plus 20 g/d P7, 20 g/d SC47 or 40 g/d DV-XP strains of yeast in a 4X4 Latin square design. A 13% high concentrate diet (9.5 kg/d) consisting of 80% of steam flaked corn, 10% soybean hulls and 10% protein/vitamin/mineral supplement was fed to each cow twice a day (60% at 0800 h and 40% at 1600 h). Yeast strains were top dressed on the respective diet at the morning feeding and mixed by hand. Cows were fed their respective diet in each period of the Latin square for 14 d. On d 12 of each period, duplicate *in situ* digestion bags (10 X 20 cm) containing substrate (12.5 mg/cm² of bag surface area) were incubated for 72, 48, 24, 12, 6, 3, 1.5, 0.5 and 0 h. Immediately after submersion of the 0 h bags of substrate into the ruminal fluid, all bags were removed and rinsed with tap water. After an initial rinse, all bags were placed into an automatic clothes washing machine and rinsed using 4 to 6 gentle cycles of agitation until rinse water was clear. Bags were then dried at 60 C for 48 h and weighed to determine DMD. The rate of DMD for CG, SG, AH and SS was 2.7, 2.1, 1.88 and 0.94 %/h, respectively. P7 and SC47 increased ($P = 0.0075$) rate of DMD of CG over that of C and DV-XP (3.28 and 3.43 vs 1.96 and 2.52 %/h, respectively). Yeast strains did not change the rate of DMD of SG, AH or SS ($P > 0.10$). The extent of DMD was similar across all treatments for CG (95.4%), SG (89.3%) and AH (74.54%). The extent of DMD of SS was decreased ($P = 0.04$) when DV-XP was fed compared C, P7 and SC47 (56.0% vs 76.9, 74.0 and 69.5, respectively). These data indicate that various yeast strains affect rate or extent of DMD of CG and SS in this study.

Key Words: Cattle, DM Disappearance, Yeast

M164 Fermentable and nutritional characteristics of fermented feedstuffs added *Aspergillus oryzae* and *Saccharomyces cerevisiae*. P. Byung Ki, R. Chang Six, and S. Jong Suh*, *Department of Animal Resources Science, Kangwon National University, Chunchon, Korea.*

This study was conducted to compare and evaluate fermentable and nutritional characteristics of fermented brewery meal with *Aspergillus oryzae* (AO) and *Saccharomyces cerevisiae* (SC). Experiments were divided into three treatment groups; FFAO (fermented feedstuff with 1% of *Aspergillus oryzae*), FFSC (fermented feedstuff with 1% of *Saccharomyces cerevisiae*), and FFAS (fermented feedstuff with 0.5% of *Aspergillus oryzae* and 0.5% of *Saccharomyces cerevisiae*). For changes of crude protein contents by 48 hours fermentation, there were no significant difference among treatments. Ether extract contents were significantly increased by 48 hours fermentation ($P < 0.05$). Neutral detergent fiber contents of FFAO, FFSC and FFAS were significantly decreased by 48 hours fermentation ($P < 0.05$), but acid detergent fiber and acid detergent lignin contents were not different. The pH of FFAO and FFAS was decreased more rapidly than that of FFSC, reaching a plateau after 24 hours ($P < 0.05$). Alcohol content was increased rapidly until 18 hours in FFAO and was increased rapidly until 12 hours in FFSC and

FFAS, and alcohol content of FFAO, FFSC and FFAS was maintained constantly after 24 hours ($P < 0.05$). The ammonia N content of FFAO, FFSC and FFAS was 0.022, 0.073 and 0.040% at 48 hours, respectively, and then ammonia N was over twice higher in FFSC compared with FFAO and FFAS ($P < 0.05$). Dextrose content was increased until 6 hours in FFAO, but it was rapidly decreased in FFSC and FFAS until 6 hours ($P < 0.05$). Lactate content was higher in FFAO and FFAS compared with FFSC ($P < 0.05$). Consequently, if AO is added for the formulation of fermented feedstuff with brewery meal, which has high moisture content, ether extract, alcohol, and lactate contents were increased, but NDF and ammonia N contents were reduced. Therefore, it is expected that AO will be effective to increase the feed value and the preservation of fermented feedstuff with a high moisture content.

Key Words: *Aspergillus oryzae*, *Saccharomyces cerevisiae*, Fermented Feedstuff

M165 Effects of chlortetracycline (CTC) and steroidal implant on growth and plasma growth hormone (GH) and thyroid hormone release after challenge with thyrotropin-releasing hormone (TRH) and GH-releasing hormone (GHRH) in beef steers. S. E. Kitts*¹, J. C. Matthews¹, G. L. Sipe¹, T. S. Rumsey², T. H. Elsasser², S. Kahl², R. L. Baldwin³, and K. R. McLeod¹, ¹University of Kentucky, Lexington, ²Growth Biology Laboratory, ARS, USDA, Beltsville, MD, ³Bovine Functional Genomics Laboratory, ARS, USDA, Beltsville, MD.

Twenty-four Simmental-Angus steers (365 kg \pm 4) were used to test the hypothesis that CTC, in the absence and presence of steroidal implant, alters composition of tissue accretion by attenuating GH and thyroid-stimulating hormone (TSH) release. Steers were assigned randomly to a 2 x 2 factorial arrangement of treatments of either 0 or 350 mg CTC/d, with and without estrogenic implant (EI). Steers received ad libitum amounts of a 80:20 concentrate-forage diet formulated to provide 105% of the MP requirement for steers gaining 1.6 kg/d. On d 0, 15, 30, 56 and 106, steers received a challenge injection via jugular catheter of 1.0 μ g/kg BW TRH + 0.1 μ g/kg BW GHRH and blood samples were collected from 30 to 360 min post-challenge. Steers were slaughtered after d 112 to determine carcass characteristics. Across the feeding period, DMI was unaffected ($P = 0.17$) by treatment; however, EI increased ($P = 0.01$) rate and efficiency of gain. Treatment did not affect ($P = 0.2$) area under the response curve (AUC) for GH, TSH, or thyroxine; however, AUC for triiodothyronine (T₃) tended to be greater ($P = 0.14$) for EI steers following each GHRH + TRH challenge. Carcass weight was greater ($P = 0.05$) and longissimus fat cover was lower ($P = 0.02$) in steers fed CTC in the absence of EI, but not in the presence of EI (interaction, $P = 0.03$). Marbling score was 13% greater ($P = 0.18$) for steers fed CTC. In conclusion, subtherapeutic feeding of CTC had subtle effects on carcass characteristics, but did not attenuate the release of GH or TSH in response to GHRH + TRH challenge. Conversely, steroidal implant increased tissue accretion and tended to increase circulating T₃ following GHRH + TRH challenge.

Key Words: Chlortetracycline, Carcass Quality, Beef Cattle

M166 Effects of salinomycin and virginiamycin on performance and carcass traits of feedlot steers. S. L. Silva¹, R. Almeida*², D. Schwahofe¹, P. R. Leme¹, and D. P. D. Lanna³, ¹FZEA/USP Pirassuninga, SP, Brazil, ²UFPR and PUCPR & LNCA-ESALQ/USP Piracicaba, SP, Brazil, ³LNCA-ESALQ/USP Piracicaba, SP, Brazil.

Seventy-two Nellore steers, with an initial BW of 416 \pm 26 kg and approximately 36 months of age, were fed for 69 days at the experimental feedlot from University of Sao Paulo. The animals were blocked by initial weight and randomly allocated to 24 pens, with three steers per pen. Steers were fed four dietary salinomycin and virginiamycin supplementation groups: control (CONT), 15 ppm of salinomycin (SAL), 16 ppm of virginiamycin (VIRG) and 10 ppm of salinomycin plus 8 ppm of virginiamycin (SAL+VIRG), mixed on ground dry corn. The commercial products used were Coxistac[®] (Salinomycin) and Phigrow[®] (Virginiamycin). During the trial period, steers were fed once daily, with meals delivered at 0700 h. Diets contained a higher proportion of roughage than normally observed in feedlots using *B. taurus* animals: 77% of DM as concentrate, 40.8% NDF, 13.5% CP and 70.5% TDN. All statistical analyses were conducted using the GLM procedure of SAS. No differences were observed for average daily gain (ADG)

for the CONT treatment compared to SAL or VIRG. But surprisingly the ADG of the SAL+VIRG treatment was 17.9% higher ($P < 0.05$) than CONT. SAL and VIRG treated steers had lower ($P < 0.05$) DMI than SAL+VIRG steers: 10.1 ± 0.4 , 10.2 ± 0.4 , and 11.3 ± 0.4 kg/d, and 2.24 ± 0.08 , 2.25 ± 0.08 , and $2.46 \pm 0.08\%$ of BW, respectively. CONT animals showed intermediate ($P > 0.05$) intakes. Feed efficiencies were not different ($P > 0.05$) among groups. Treatments with higher gains had also greater intakes. Nevertheless, even without statistical differences, there were improvements of 5.6, 8.3, and 8.0% in feed efficiency, respectively for SAL, VIRG and SAL+VIRG, over controls. Few differences were observed on carcass traits between supplemented and control steers. Among them, steers fed SAL had higher backfat thickness than ($P < 0.01$) CONT and than ($P < 0.05$) VIRG and SAL+VIRG steers: 8.7 ± 0.7 vs. 6.3 ± 0.7 , 6.8 ± 0.7 and 6.8 ± 0.7 mm, respectively. The improvements in efficiency are very consistent with previous research and would have important economical and environmental impact.

Key Words: Beef Cattle, Ionophores, Antibiotics

M167 Effects of semduramicin on performance and carcass traits of feedlot steers. R. Almeida^{*1}, S. L. Silva³, R. T. Y. B. Souza³, D. P. D. Lanna², and P. R. Leme³, ¹UFPR and PUCPR & LNCA-ESALQ/USP Piracicaba, SP, Brazil, ²LNCA-ESALQ/USP Piracicaba, SP, Brazil, ³FZEA/USP Pirassununga, SP, Brazil.

Forty-three Nelore steers, approximately 36 months of age, were individually fed in outdoor pens with electronic Calan gate feeders at University of Sao Paulo experimental feedlot. The animals were blocked by initial weight and randomly assigned to four levels of dietary Aviax[®]: 0, 45, 67.5, or 90 mg semduramicin/head/day. After a 27-day adaptation period, steers had an average shrunk weight of 457 ± 18 kg at the beginning and 540 ± 19 kg at the end of the trial. During the 62-day experimental period, steers were fed once daily at 0900 h. Because *B. indicus* steers are more liable to develop acidosis, roughage content was higher than normally observed in feedlots using *B. taurus*: 77% of DM as concentrate, 40.8% NDF, 13.5% CP and 70.5% TDN. Data were analyzed using the REG and the GLM procedures of SAS. Average daily gain was not affected ($P > 0.05$) by semduramicin supplementation, although steers treated with 67.5 mg had increased daily gains of 0.136 kg/day above controls. Steers supplemented with 90 mg had lower dry matter intakes ($P < 0.05$) than steers supplemented with 67.5 mg of semduramicin. During the evaluation period, intakes for steers supplemented with 67.5 and 90 mg were: 11.73 ± 0.30 and 10.73 ± 0.28 kg/day, and 2.35 ± 0.06 and $2.12 \pm 0.05\%$ of BW, respectively. Feed efficiency (BWG/DMI) was not different ($P > 0.05$) between treated and non-treated steers. Improvements in overall feed efficiency were observed to be: 2.8, 7.4, and 7.3% for treatments 45, 67.5, and 90 mg, respectively, over controls ($P > 0.05$). However, there was an improvement in feed conversion efficiency determined as residual feed intake calculated by regression ($P < 0.05$). Carcass characteristics from supplemented steers did not differ ($P > 0.05$) from the controls. The improvements in efficiency are very consistent with previous research with other ionophore molecules and would have important economical and environmental impact.

Key Words: Beef Cattle, Nelore, Ionophores

M168 Chlortetracycline, but not Synovex-S, differentially affects tissue expression of high-affinity glutamate transporters in fattening steers. G. L. Sipe^{*}, S. E. Kitts, K. R. McLeod, and J. C. Matthews, University of Kentucky, Lexington.

Chlortetracycline (CTC) fed sub-therapeutically and estrogenic growth implants (Synovex-S; S) are used to alter the amount and site of skeletal muscle and/or adipose tissue accretion of fattening cattle. However, effect(s) of these nutrient-repartitioning agents on nutrient absorption capacity are unknown. Because the expression of two high-affinity glutamate transporters, GLT-1 and EAAC1, by tissues of fattening steers is sensitive to physiological load (Gissendanner et al., 2003, FASEB J. 17(5):A738), this study was conducted to determine if expression of GLT-1 or EAAC1 was affected by none (control; C), S (d0 and d56 implanted) and/or CTC (350 mg/d) treatment ($n = 6$) of Simmental x Angus steers (BW = 350 ± 10 kg) fed a finishing diet (see companion abstract, Kitts et al., 2004) for 112 d. Immunoblot analysis was used to determine the relative content of EAAC1 and GLT-1 in plasma membrane vesicles isolated from the duodenum (D), jejunum (J), ileum (I), liver (L), skeletal muscle (M, longissimus dorsi), subcutaneous fat (SF), omental fat (OF) and interstitial fat (IF). EAAC1 and GLT-1 content

of D, J, and I ($P > 0.48$), and EAAC1 content of L and M ($P > 0.53$), were not affected by treatments. In contrast, for CTC steers, M GLT-1 content was 128% greater ($P < 0.01$) than C steers, whereas L GLT-1 content was 236% and 160% greater ($P < 0.008$) than C and S, respectively. For adipose tissues, SF EAAC1 content did not differ ($P > 0.94$), but OF EAAC1 content of CTC steers was 74% greater ($P < 0.078$) than C. CTC steers also contained 319% more ($P < 0.053$) IF EAAC1 than S, but not C ($P > 0.26$) animals. OF and IF GLT-1 did not exhibit a treatment effect ($P > 0.33$) in contrast to SF GLT-1 content, which was 524% ($P < 0.08$) and 237% ($P < 0.09$) greater in CTC than for C and S steers, respectively. Although Synovex-S had no effect, CTC appears to increase the capacity for glutamate absorption by up-regulating GLT-1 (L, M, SF) and EAAC1 (OF, IF) expression, in contrast to having no effect on intestinal epithelium.

Key Words: Gene Expression, SLC1A1, SLC1A2

M169 Influence of genotype and diet on steer performance. C. L. Ferrell^{*}, E. D. Berry, H. C. Freetly, and D. N. Miller, USDA-ARS; U.S. Meat Animal Research Center, Clay Center, NE.

Objectives were to evaluate genotype and diet effects on steer performance during the growing period and subsequent responses to a high concentrate diet during the finishing period. Fifty-one [MARC III (M; 14) and Brahman cross (Bx; 37)] steers were allotted to eight pens and individually fed chopped brome grass hay (BG; $N = 26$; $DM = 0.85$, $CP = 9.5\%$, $ME = 2.19$ Mcal/kg) or a corn silage based diet (CS; $N = 25$; $DM = 0.51$, $CP = 11.9\%$, $ME = 2.75$ Mcal/kg) for 119 d (PD1) followed by a high corn diet (HC; $DM = 0.79$, $CP = 11.7$, $ME = 3.08$ Mcal/kg) to a target wt of 560 kg (PD2). Data were analyzed by ANOVA with genotype, diet (BG, CS), and the two-way interaction included. The interaction was not significant. Initial (273 kg) and final wts (559 kg) did not differ due to genotype or diet, but wt of BG (325 kg) steers was less than CS (384 kg) steers at the end of PD1. ADG and intake of DM, CP, and ME were less ($P < 0.05$) for Bx than for M during PD1, PD2 and total, but efficiency of M and Bx was similar ($P > 0.40$). Carcass wt, marbling, quality grade, and REA were similar ($P > 0.12$), but Bx steers had greater backfat (1.26 vs. 0.87 cm) and yield grades ($P = 0.07$) than M steers. During PD1, daily DMI (6.91 vs. 7.11 kg) was similar, but CP (0.66 vs. 0.85 kg) and ME (15.2 vs. 19.5 Mcal) intake of BG was less ($P < 0.001$) than CS. DMI/gain (21.5 vs. 6.9), CP intake/gain (2.06 vs. 0.83), and ME intake/gain (47.1 vs. 19.2 Mcal/kg) were greater in BG. CS manure accumulated more total VFA but less branched-chain VFA and aromatics than BG manure. When fed the HC diet (PD2), feed intake, ADG, and efficiency were improved ($P < 0.02$) in the BG vs. CS steers. Shedding of *E. coli* 0157 was associated with reduced DMI and ADG ($P < 0.10$). Over the total study, ADG was lower (0.97 vs. 1.03 kg), and DMI (8.50 vs. 7.62) and DMI/gain (8.09 vs. 7.17) were greater in BG than in CS fed steers, but neither CP intake/gain (0.86 vs. 0.84) nor ME intake/gain (22.2 vs. 21.1) differed. Carcass weight, backfat, and yield grade were greater ($P < 0.04$) for CS than for BG, but marbling, quality grade, and REA did not differ.

Key Words: Efficiency, Odor, *E. coli*

M170 Zinc increases differentiation of bovine intramuscular adipocytes by suppressing nitric oxide production and increasing PPAR γ 2 gene expression. Y. S. Oh¹, S. B. Smith², and C. B. Choi^{*1}, ¹Department of Animal Science, Yeungnam University, Gyeongsan, Korea, ²Department of Animal Science, Texas A & M University, College Station.

Zinc (Zn) is a micromineral that functions as a cofactor of many enzymes and is known, recently, to be involved in adipocyte metabolism, insulin resistance, and obesity. This study was conducted to determine the effects of Zn on the differentiation of bovine intramuscular adipocytes and on the production of nitric oxide (NO). Preadipocytes were isolated from intramuscular fat depots of 26-mo-old (adult) Korean (Hanwoo) steers and maintained in Dubelcco's Modified Eagles's Media (DMEM) containing 5% FBS. At confluence, the cells were treated with 10 μ g/mL insulin, 0.25 μ M dexamethasone, and 0.5 mM 1-methyl-3-isobutyl-xanthine to induce differentiation (accumulation of lipid droplets) for 48 h. Zinc was supplemented to the differentiation media in the form of either zinc chloride ($ZnCl_2$) or zinc sulfate ($ZnSO_4$) to attain the final concentrations of 0, 5, 25, 50 and 100 μ M. Glycerol-3-phosphate dehydrogenase (GPDH) activity, an index of adipocytes

differentiation, was significantly ($P < 0.05$) increased as the concentration of both forms of Zn in media increased, showing the highest activity (25.74 ng/min/mg protein) at 25 μM ZnSO_4 at 10 d after differentiation induction. On the other hand, supplementation of Zn into the media of bovine intramuscular adipocytes tended ($P > 0.05$) to decrease (from 15 μM to 10.5 μM) the production of NO. Peroxisome proliferator-activated receptor gamma 2 (PPAR γ 2) gene expression in bovine intramuscular adipocytes was increased at 10 d after differentiation induction by treatment with Zn. The current results indicate that Zn strongly promotes lipogenic activity in cultured bovine intramuscular adipocytes via suppression of NO production. These data further indicate that Zn may increase adipocyte differentiation by stimulating PPAR γ 2 gene expression.

Key Words: Zinc, Nitric oxide, PPAR γ 2

M171 Performance and residual feed intake differences between steers housed in individual or group pens. P. V. Paulino^{1,2}, F. C. Castro¹, A. C. Magnabosco^{1,3}, and R. D. Sainz¹, ¹University of California, Davis, ²Universidade Federal de Vicosa, Vicosa, MG Brasil, ³Universidade Catolica de Goias, Goiania, GO, Brasil.

Residual feed intake (RFI) is a useful measure of feed efficiency, but it requires individual records of dry matter intake (DMI) as well as body weight gain (ADG). There is some question as to the behavioral differences in animals fed individually vs. those in a group. Thirty Angus \times Hereford (AX) and 30 (Angus \times Hereford) \times Gelbvieh (GX) steers were fed a corn-based diet on an *ad libitum* basis for 84 days in individual ($n = 24$) or in group pens ($n = 36$, 6/pen). Feed intakes were recorded weekly and steers were weighed every 28 days. Average ADG was estimated by individual or pen as the slope of the regression of body wt and time. Residual feed intake was calculated as the difference between observed dry matter intake (DMI) and that predicted by regression: $E(\text{DMI}) = 0.0491 \text{ BW}^{0.75} + 2.07 \text{ ADG}$, $R^2 = 0.81$. DMI required for maintenance (DMI-M) was estimated as $\text{DMI} - 2.07 \text{ ADG}$, i.e., assuming a constant net efficiency for gain. DMI, ADG, RFI and DMI-M were analyzed using the GLM procedure of Minitab. Model effects were genotype, housing, and their interaction. DMI was higher ($P < 0.05$) for AX (8.17 kg/d) than GX (6.89 kg/d) steers and for animals housed in group (8.18 kg/d) compared to individual pens (6.87 kg/d). Consequently, AX steers gained more ($P < 0.05$) weight (1.37 kg/d) than GX steers (0.97 kg/d), and animals in individual pens gained more ($P < 0.05$) than those housed in groups (1.29 and 1.06 kg/d, respectively). RFI was higher ($P < 0.05$) in AX than GX steers. A significant ($P < 0.05$) genotype \times housing interaction was detected only for RFI, because the difference in RFI between genotypes was larger for the animals housed in group pens than for those housed individually. For both genotypes, animals housed in group pens had higher RFI values than animals housed individually. This could have been due to higher maintenance requirements, since DMI-M was higher in AX than GX steers (+8.5%, $P < 0.05$), and in group-fed than individually-fed steers (+10.1%, $P < 0.05$). Type of housing had significant effects on performance and feed efficiency in the feedlot and this effect was not uniform across genotypes. These results raise questions about the protocols for measuring RFI. Financial Support: CAPES

Key Words: Residual Feed Intake, Beef Cattle, Feed Efficiency

M172 Effect of supplemental chromium on tissue chromium concentrations in cattle. J. W. Spears^{*1}, K. E. Lloyd¹, M. E. Tiffany¹, and M. T. Socha², ¹North Carolina State University, Raleigh, ²Zinpro Corp, Eden Prairie, MD.

Supplemental chromium (Cr) has increased performance of dairy cows and immunity of stressed beef calves. Experiments were conducted to determine the effects of supplemental Cr on: 1) tissue Cr concentrations in finishing beef steers and dairy cows and 2) placental transfer of Cr in calves. In Exp. 1, liver and kidney samples were obtained at harvest from 36 Angus and Angus-cross steers (initial BW 332 kg) that received either: 1) control (no supplemental Cr), 2) 0.4 mg Cr/kg DM from Cr-nicotinic acid complex (CrNA), 3) 0.8 mg Cr/kg DM from CrNA or 4) 0.8 mg Cr/kg DM from Cr chloride. Experimental diets were fed for 146 d. Chromium concentrations were low in liver ($\bar{X} = 11.4 \mu\text{g/kg DM}$) and kidney ($\bar{X} = 20.6 \mu\text{g/kg DM}$), and were not affected by Cr supplementation. Twenty-four Angus and Angus-cross steers (initial BW 288 kg) were randomly assigned to treatments consisting of 0, 0.2, 0.4

or 0.8 mg supplemental Cr/kg DM from Cr-L-methionine (MiCroPlex[®]; CrMet) in Exp. 2. Steers were fed a growing diet for 125 d prior to harvest. Control steers had higher ($P < 0.05$) muscle Cr concentrations than Cr-supplemented steers. Liver ($\bar{X} = 41.3 \mu\text{g/kg DM}$) Cr concentrations were not affected by treatment. In Exp. 3, 18 Holstein cows, at approximately 35 d prepartum, were assigned to either 0 or 0.06 mg Cr/kg metabolic BW from CrMet daily via gelatin capsule. Calves were harvested at birth prior to nursing to determine placenta transfer of Cr. Cows continued to receive treatments until 30 d postpartum, at which time they were harvested. Calves born to Cr-supplemented dams had higher ($P < 0.01$) Cr concentrations at birth in semitendinosus muscle (98 vs 68 $\mu\text{g/kg}$) than controls. Supplemental Cr did not affect Cr concentrations in liver, heart or kidney of calves. Similarly, Cr concentrations in tissues of cows were not affected by supplemental Cr. These studies indicate that supplementing low concentrations of Cr to ruminant diets had minimum effects on tissue Cr concentrations.

Key Words: Chromium, Cattle

M173 Magnesium sulfate affects water consumption and drinking behavior of beef cattle. A. S. Grout¹, D. M. Veira^{*2}, D. M. Weary¹, M. A. G. von Keyserlingk¹, and D. Fraser¹, ¹Animal Welfare Program, University of British Columbia, Vancouver, British Columbia, Canada, ²Agriculture and Agri-Food Canada, Kelowna, British Columbia, Canada.

Sulfate (SO_4) salts of Na and Mg are common in rangeland water sources and pose problems for animal health, production and welfare. This experiment considered the effect of Na_2SO_4 and MgSO_4 on water consumption, fecal DM and drinking behavior of cattle. Sixteen yearling Hereford and Hereford Angus cattle (initial weight: 421 ± 24 kg) were watered twice daily with tapwater (16 ppm SO_4) or water containing Na_2SO_4 at concentrations of 2000 ppm SO_4 (low Na_2SO_4), MgSO_4 at 2000 ppm SO_4 (low MgSO_4) or MgSO_4 at 4000 ppm SO_4 (high MgSO_4) in 21-d treatment periods separated by 7-d interim periods when all animals were given tapwater. Treatments were applied in an incomplete Latin Square where each animal was exposed to 3 of the 4 treatments yielding 8 animals for each treatment comparison. Paired t-tests were used for analysis of average daily water consumption, fecal DM and refusals to drink. Variability in water consumption patterns was assessed by Wilcoxon paired sample tests. Daily water consumption was highest for tapwater (41.3 ± 6.6 L/d; $P < 0.01$) and lowest for high MgSO_4 -water (24.4 ± 9.0 L/d; $P < 0.01$). Response to high MgSO_4 -water was highly variable, with mean daily consumption ranging from 12.4 to 40.9 L. After 11 d on treatment, fecal DM was not different for any of the treatments, but was higher ($P < 0.03$) after 21 d of high MgSO_4 -water. Of the 42 drinking opportunities per treatment (twice per day \times 21 d), cattle refused to drink 10.1 ± 6.3 times on high MgSO_4 -water compared to 1.5 ± 1.9 times on tapwater ($P < 0.05$). Variation in intake was larger for high MgSO_4 -water (SD of 42 intakes = 11.7) than for tapwater (6.3) and low MgSO_4 -water (8.9) ($P < 0.05$). These findings indicate that high levels of MgSO_4 in water can lead to lower and more variable water consumption sufficient to increase fecal DM. Some cattle also forgo drinking when offered high MgSO_4 -water, further indicating that this water is unacceptable to cattle.

Key Words: Water Quality, Sulfate, Drinking Behavior

M174 Selenium concentration of colostrum and milk from beef cows receiving different forms of selenium supplementation. P. A. Davis^{*}, L. R. McDowell, R. Van Alstyne, E. Y. Matsuda-Fugisaki, and N. S. Wilkinson, Department of Animal Sciences, University of Florida, Gainesville.

Forty-three Angus cows (125-150d gestation) were stratified by age and randomly assigned to five groups receiving either no selenium (Se) supplementation (control), 5 ml sodium selenite via subcutaneous injection (Mu-Se, Burns Biotech Labs, Inc. Oakland, CA) every four mo, 9 ml barium selenate via subcutaneous injection (Deposel, Grampian Pharmaceuticals Ltd, Lancashire, UK), sodium selenite, or selenized yeast (Se-Plex, Alltech, Nicholasville, KY) via free-choice (FC) salt-based mineral mixtures (26 ppm Se) in a one year experiment to evaluate the effects of selenium supplementation methods on milk Se concentration. Animals on each treatment grazed bahiagrass pastures and received bahiagrass hay (< 0.02 ppm Se DM basis) during winter. Colostrum and

subsequent milk was collected at parturition, 30, 90, and 180 d postpartum. Samples were analyzed for selenium concentration using a fluorometric method. Colostrum Se concentration did not differ ($P < 0.05$) among control, Deposel, Mu-Se and FC sodium selenite treatments and were below critical level (0.05 ppm) at 0.038, 0.035, 0.035, and 0.038 ppm, respectively. Sel-Plex was higher ($P < 0.05$) than control and all other treatments at 0.071 ppm. At 30 d postpartum, Sel-Plex was higher ($P < 0.05$) than control and both injectable products. FC sodium selenite was higher ($P < 0.05$) than both Mu-Se and Deposel and tended to be higher than control ($P = 0.07$). At 90 d postpartum, milk Se concentrations did not differ among treatments with Sel-Plex tending ($P = 0.07$) to be higher than Mu-Se. Milk Se concentrations did not differ at 180 d among control, Deposel, Mu-Se, and FC sodium selenite, however, Sel-Plex was higher ($P < 0.05$) than all other treatments at 0.042 ppm. At no time during the study did either injectable Se source produce milk Se concentrations higher than control or above the critical level. FC sodium selenite outperformed both injectable products only at 30 d. Overall, milk Se concentrations from cows receiving Sel-Plex were higher than all other treatments.

Key Words: Beef Cattle, Colostrum, Selenium Supplementation

M175 Effect of high-level copper supplementation on copper status and performance of beef heifers consuming molasses-based supplements. J. D. Arthington* and F. M. Pate, *University of Florida, Range Cattle Research and Education Center, Ona, FL.*

The objective of this study was to examine the effects of high-levels of Cu supplementation on the performance and Cu status of growing steers consuming molasses-based supplements. Twenty-four crossbred heifers were stratified by BW and randomly assigned to individual pens. Four treatments, consisting of a complete mineral supplement fortified with 0, 15, 60, and 120 ppm supplemental Cu (Cu sulfate), were randomly assigned to pens (6 pens/treatment). Treatments were offered 3 times weekly in molasses-cottonseed meal slurry (1.5 kg of TDN and 0.3 kg of CP/hd). All heifers were offered free-choice access to ground star-grass hay. Individual BW, jugular blood, and liver biopsy samples were collected d 0, 42, and 84. Forage DM refusal was determined daily. Diet DM digestibility was estimated over a 21 d period (beginning on d 42) by the use of a sustained release chromic oxide bolus (Captec, New Zealand). Heifers consuming the highest rate of supplemental Cu (120 mg/kg) tended ($P = 0.13$) to have a lesser ADG compared to heifers supplemented with 15 mg/kg of Cu (0.18 vs. 0.05 kg/d; SEM = 0.06). There was no significant sampling day x treatment interaction for liver Cu accumulation, however average liver Cu concentrations among all treatments decreased ($P < 0.05$). Therefore, data were also analyzed combining treatments that provided 60 and 120 mg/kg of supplemental Cu into a single treatment (High Cu). Heifers supplemented with 15 mg/kg Cu had a greater ($P < 0.05$) increase in liver Cu concentration compared to 0 ppm and High-Cu treatments (average change = -200, 5, -109 ppm DM for Control, 15 ppm, and High-Cu treatments, respectively; SEM = 46.8). Forage DMI was lower ($P = 0.07$) for heifers receiving no supplemental Cu compared to all other treatments (6.6 vs. 5.8 kg/d; SEM = 0.37). Apparent forage digestibility was not affected ($P > 0.05$) by Cu treatment. These data suggest that high rates of Cu supplementation (Cu sulfate; > 60 ppm total Cu) results in a decline in liver Cu accumulation into the liver of beef heifers consuming molasses supplements.

Key Words: Cattle, Copper, Molasses

M176 Supplemental phosphorus removal for finishing yearling Holstein steers. A. M. Brokman*¹, J. W. Lehmkuhler¹, and D. J. Undersander¹, ¹*University of Wisconsin-Madison, Madison*, ²*University of Wisconsin, Madison*.

Two experiments were performed to determine responses of removing supplemental phosphorus from the finishing ration offered to yearling Holstein steers. In Experiment 1, 96 Holstein steers (419 kg) were blocked into four weight groups and assigned to eight pens. Steers were fed a diet consisting of approximately 74% corn, 18% corn silage and 8% supplement on a DM basis. Dietary treatments, supplemental phosphorus (DC) or no supplemental phosphorus (NDC), were randomly assigned to pens within each block. The phosphorus (dicalcium phosphate) was pre-incorporated into the protein/mineral pellet at a level to

achieve 0.3% in the complete ration. Steers were implanted with an estrogenic product on d 0. Steers in heavier weight blocks were harvested after 82 d to avoid heavy carcass weight discounts. The remaining steers were harvested on d 125. Carcass data were collected following a 24-hr chill. No differences ($P > 0.05$) were detected in carcass characteristics. NDC tended to be heavier at the end of the trial ($P = 0.07$). During period three NDC resulted in heavier weights ($P < 0.05$) and a trend for better gain efficiency ($P = 0.09$). The overall gain efficiency for NDC was better than DC ($P < 0.05$). Experiment 2 consisted of 78 Holstein steers (491 kg) blocked into two weight groups. Steers were fed a TMR consisting of approximately 81% corn, 8% supplement, 6% corn silage, and 5% alfalfa haylage on a DM basis. Steers were implanted as in Experiment 1. Steers were harvested on d 84 and 112 d on test. Carcass data were collected after a 48-hr chill. NDC carcasses tended to have a higher trim weight ($P = 0.09$) and a lower percent trimmed than DC carcasses ($P = 0.05$). No differences ($P > 0.05$) were detected in overall ADG (DC=1.63 kg vs. NDC=1.63 kg), weights, overall dry matter intake or gain efficiency (DC=0.15 vs. NDC=0.15). A trend existed for DC to have higher DMI ($P = 0.10$) during period three in comparison to NDC. Removing supplemental phosphorus from the feedlot diet did not produce adverse effects on steer performance or carcass characteristics for yearling Holstein steers.

Key Words: Beef, Holstein, Feedlot

M177 Evaluation of machine milking and weigh-suckle-weigh technique for quantification of milk production at six or twelve hour udder-fill intervals. W. J. Sexten*, D. B. Faulkner, and J. M. Dahlquist, *University of Illinois, Urbana.*

A randomized complete block design with a 2 x 2 factorial arrangement was utilized to evaluate the effects of collection method and udder-fill interval on milk production estimates collected during middle (Exp. 1) and peak lactation (Exp. 2). Each cow represented a block to which all four of the possible treatment combinations were applied. Factors tested were milk collection method, using a portable milk machine (MM) or weigh-suckle-weigh (WSW), and udder-fill intervals of 6 h (6) or 12 h (12). Twenty-four Simmental cows were utilized in Exp. 1 ($n = 96$) that were 119.4 ± 2.8 d postpartum. The 24 Simmental cows used in Exp. 2 ($n = 96$) were 64.5 ± 0.05 d postpartum. A collection method by udder-fill interval interaction was observed ($P = 0.01$) in Exp. 1 and 2. Milk machine estimates did not differ ($P = 0.11$) due to udder-fill interval, while WSW estimates were lower ($P < 0.05$) at 6 h than 12 h in both Exp. Estimates taken using a 6 h udder-fill interval were lower ($P < 0.001$) for WSW than MM in Exp. 1 and 2. In Exp. 1, 12 h estimates did not differ ($P = 0.81$) due to collection method however in Exp. 2 estimates taken using MM-12 tended higher ($P < 0.10$) than WSW-12. A positive correlation ($P = 0.001$) was observed between WSW estimates at 6 and 12 h in Exp 1 (0.77) and Exp. 2 (0.62). Milk machine estimates at 6 and 12-h were positively correlated ($P < 0.01$) in Exp. 1 (0.62) and Exp. 2 (0.62). Weigh-suckle-weigh and MM estimates were not correlated ($P > 0.05$) at any udder fill interval. Regression of WSW-12 on WSW-6, MM-12 and MM-6 confirmed correlation results, as WSW-6 in Exp. 1 was the only estimate predicted by WSW-12. The quadratic effect of WSW-12 did not influence ($P > 0.15$) predictions indicating calf capacity for milk consumption did not influence milk production estimates. These experiments suggest milk production estimates taken using different collection methods are not comparable.

Key Words: Milk Production, Machine Milking, Weigh-Suckle-Weigh

M178 Effect of esterase enzyme treatment on the in situ rumen degradability and soluble carbohydrate content of tropical grasses. N. A. Krueger*, A. T. Adesogan, D. B. Dean, and W. K. Krueger*, *University of Florida, Gainesville.*

Previous work showed that application of an esterase enzyme preparation (Depol 740, Biocatalyst, U.K.) increased the digestibility in vitro of tropical grasses. This study examined the effect of the same enzyme preparation on the water soluble carbohydrate (WSC) fraction and the in situ degradability of three tropical grass hays. The enzyme was applied at 0, 0.5, 1, 2, and 3 g/100g DM on hay produced from 12-wk regrowths of common bahiagrass (B), Coastal bermudagrass (C), and Tifton 85 bermudagrass (T) 24 h before ruminal incubation. Duplicate samples of each forage were incubated in each of two cows for 0, 3, 6,

9, 12, 24, 48, 72, 96, and 120 h. The cows diet consisted of bermudagrass hay supplemented with 0.4 kg/d of soybean meal. Treatments were arranged in a 2 x 3 x 5 factorial design. The McDonald model, $P = A + B(1 - \exp^{-c(t-L)})$, was fitted to the in situ data. There was a cubic increase ($P = 0.04$) in the WSC fraction as enzyme application increased. Increasing enzyme application rate also produced quartic increases in the wash fraction ($P = 0.0036$), degradation rate ($P = 0.0047$), effective degradability and total degradability ($P = 0.0053$; 643, 651, 622, 663, 661, and 648 g/kg DM) of the hays. The potentially degradable fraction (B) also tended to increase ($P = 0.071$) with increasing enzyme rate whereas the lag phase decreased cubically ($P = 0.0106$). The highest degradation rate (0.03 per hour) occurred at the 1% enzyme application rate but the shortest lag phase occurred at the 3% rate. In conclusion, application of the esterase enzyme enhanced the release of WSC from the hays and increased the rate and extent of degradation of the hays.

Key Words: Tropical Grass, Esterase, Degradation

M179 Effect of exogenous amylase and corn type on performance and carcass characteristics of finishing beef heifers. S. M. Speight^{*1}, K. C. Hanson¹, J. Tricarico², K. R. McLeod¹, and D. L. Harmon, ¹University of Kentucky, Lexington, ²Alltech Biotechnology, Inc., Nicholasville, KY.

Two experiments were conducted to evaluate the efficacy of feeding a fungal amylase preparation on the performance and metabolism of beef cattle fed high grain diets. Experiment 1 used 12 rumen cannulated steers divided into one of three dietary treatments: 1) control, no enzyme; 2) 5 g/d amylase; or 3) 10 g/d amylase enzyme preparation. The diet consisted of 50% concentrate (corn-based), 50% corn silage. There was no effect of exogenous amylase on daily dry matter intake, VFA proportions, total concentrations, acetate:propionate or ruminal pH. In situ starch disappearance was also unaffected by treatment. In Experiment 2, 96 crossbred heifers were fed finishing diets until slaughter to evaluate the effects of corn type and inclusion of an exogenous amylase preparation on animal performance and carcass characteristics. Animals were assigned randomly to a 2 x 3 factorial arrangement of treatments in a completely randomized design. Factors were corn type (dry vs. high moisture) and amount of exogenous amylase preparation (0, 7.5, or 15 g amylase/(hd·d)). There were no differences in corn type throughout the study. During the first 28 d, average daily gain increased linearly ($P < 0.05$) with amylase supplementation. However, this increase in gain was not observed during the remainder of the trial. The increased average daily gain during the first 28 d was largely the result of increased intake (quadratic $P < 0.05$), as feed efficiency was not affected. The greatest longissimus area ($P < 0.05$) and lowest ($P < 0.05$) yield grades, as well as a tendency ($P < 0.10$) for lower back fat, were observed in heifers receiving amylase at 7.5 g/(hd·d). These studies suggest that the amylase preparation used may be beneficial for starting calves on feed but we saw no effects on fermentation or starch degradation that would suggest long term benefits with addition to finishing diets.

Key Words: Amylase, Supplementation, Cattle

M180 Effect of an exogenous fibrolytic enzyme on intake and ruminal variables in lambs fed Guinea grass (*Panicum maximum* var. Mombasa) hay. J. H. Avellaneda-Cevallos¹, S. S. González^{*2}, J. M. Pinos-Rodríguez³, A. Hernández², R. Bárcena-Gama², M. Cobos², and D. Hernández-Sánchez², ¹Universidad Técnica Estatal de Quevedo UTEQ, Quevedo, Ecuador, ²Colegio de Postgraduados Montecillo, Estado de México, México, ³Universidad Autónoma de San Luis Potosí UASLP, Estado de San Luis Potosí, México.

This study was performed to evaluate the effect of an exogenous fibrolytic enzyme (enzyme; Fibrozyme) on intake, digestion and ruminal variables in lambs fed Guinea grass hay. Four Suffolk lambs fitted with permanent ruminal and duodenal cannulas were fed only Guinea hay cut 35 d (11.4% CP) or 90 d (6.4% CP) after regrowth. Experimental design was a repeated Latin Square (4x4) with a factorial arrangement of treatments (2x2; enzyme, 0 and 3 g; Guinea hay 35 and 90 d). Guinea 90 d increased ($P < 0.05$) DM flow to duodenum and feces. Lambs fed Guinea 35 d showed an increased digestion of DM ($P < 0.05$) and OM ($P < 0.01$) in the rumen and intestine; higher ($P < 0.01$) intake, ruminal and total CP degradation, and retained N; and increased ($P < 0.01$) rate of passage. NDF intake ($P < 0.09$) and flow to duodenum and feces ($P < 0.01$) was higher, but ruminal and total digestion was lower

($P < 0.01$) for lambs fed Guinea 90 d. ADF flow to duodenum and feces was increased ($P < 0.01$) by Guinea 90 d; whereas ruminal, intestinal and total ADF digestion was increased ($P < 0.01$) by Guinea 35 d. ADF flow to duodenum was decreased ($P < 0.01$), but ADF ruminal degradation ($P < 0.01$) and hemicellulose intestinal digestion ($P < 0.08$) were increased, by enzyme addition for both hays. Lambs fed Guinea 35 d showed higher ($P < 0.01$) intake, ruminal and total degradation of hemicellulose, as well as increased ($P < 0.01$) ammonia-N (0, 3, 6, 9 and 12 h). pH (0, 3, 6, 9 and 12 h) was higher ($P < 0.01$) for lambs fed Guinea 35 d. According to these results, there were differences between Guinea hay 35 and 90 d for most of the variables, whereas the exogenous fibrolytic enzyme improved digestion of ADF and hemicellulose.

Key Words: Intake and Digestion, Exogenous Fibrolytic Enzyme, Tropical Grass

M181 Evaluation of modified sodium silicate as a grain conditioner for corn and grain sorghum. C. R. Richardson^{*1}, K. F. Wilson¹, T. C. Bramble¹, J. H. Mikus¹, and I. Cisneros², ¹Texas Tech University, Lubbock, ²Concorde Technologies, Odessa, TX.

Laboratory experiments at Texas Tech Univ. and two trials at a commercial feedyard feedmill were conducted to determine the effects of a modified sodium silicate product (RumiSil) on conditioning corn and grain sorghum. RumiSil has a pH of 11.2, freezing point of 0° C, specific gravity of 1.05, and low corrosive properties. Time required for the uptake of 6% added moisture by corn and grain sorghum was determined in roll jars and recorded with a stopwatch. Treatments were 0, 0.5, 1.0, 1.5, and 2.0 ml of RumiSil diluted with water to make 100 ml of each solution and were added to increase moisture content by 6 percentage points. RumiSil decreased ($P < 0.05$) time to absorb the 6% added moisture at levels of 0.5 and 1.0, with a further reduction ($P < 0.05$) at levels of 1.5 and 2.0 for both grains. In vitro DMD was increased ($P < 0.05$) for corn at the lowest level of RumiSil, while grain sorghum was improved ($P < 0.05$) at the two highest levels. Two trials were conducted to compare the 1.5 level of RumiSil to water alone in flaking corn at four flake weights. In trial one, the average starch availability was higher across flake densities (water 39.5%, SD 8.35 vs. RumiSil 52.0%, SD 8.21). In trial two, starch availability was 42.3 (SD 7.46) and 47.8 (SD 7.18) for water and RumiSil, respectively.

Key Words: Steam Flaking, Grain Processing, Grain Conditioner

M182 Effects of replacing rice straw with wormwood (*Artemisia Montana* Pampan) silage in the diets of Korean Hanwoo steers on performance, carcass characteristics and muscle fatty acid profile. S. C. Kim^{*1}, J. H. Kim^{*2}, J. H. Shin², A. T. Adesogan¹, and Y. D. Ko², ¹Department of Animal Science, University of Florida, Gainesville, ²Division of Applied Life Science, Gyeongsang National University, Jinju, Korea.

This study was conducted to examine the performance, carcass characteristics and muscle fatty acid profile of Hanwoo steers fed diets containing four levels of wormwood silage. Twenty Hanwoo steers (326 ± 23kg) with similar ($P > 0.05$) initial body weights across treatments were fed at 3% of body weight on a DM basis for 12 months. The steers were individually fed a basal diet of rice straw (30%) and supplementary concentrates (70%; corn grain, 36.5%; wheat grain, 15.0%; coconut meal, 11%; wheat flour, 5.0%; corn gluten, 3%; palm meal, 6%). The steers were allotted to one of four dietary treatments, which were designed to progressively substitute rice straw with 0, 5, 10 and 15% of wormwood silage in the basal diet. Feed intake was calculated daily and body weight was measured monthly. At the end of the trial, the steers were slaughtered and graded by trained carcass evaluators, using the Korean meat-grading scheme. The fatty acid profile of meat samples (300g) obtained from the loin and top round muscles was analyzed by gas chromatography. Final body weight, average daily gain and feed conversion efficiency were improved ($P < 0.05$) by substituting 5, 10 and 15% of straw with wormwood silage, but there were no differences in performance between the levels of wormwood silage substitution. Compared to steers in the control group, steers fed diets containing wormwood silage had greater ($P < 0.05$) carcass weight, carcass quality, and loin-eye area and less ($P < 0.05$) backfat thickness. Steers fed wormwood silage also had higher ($P < 0.05$) muscle CLA content and higher ($P < 0.05$) omega 6:omega 3 fatty acid ratios than steers in the control group. It is concluded that substituting rice straw with wormwood silage

improved the performance, carcass characteristics and muscle fatty acid profile of Hanwoo steers.

Key Words: Wormwood Silage, Hanwoo Steer, Conjugated Linoleic Acid

M183 Rumen digestibility of receiving rations for feedlot steers containing wheat midds and soybean hulls. P. M. Walker^{*1}, K. E. Earing¹, L. A. Mathews¹, and J. E. Ringler², ¹Illinois State University, Normal, ²University of Kentucky, Lexington.

Six Simmental-Angus, ruminally fistulated steers were used in a two period crossover design in situ trial to evaluate the rumen digestibility of a wheat mid-*soybean hull* ration (WS) and a shelled corn-commercial protein supplement ration (SC). Steers were randomly assigned to treatment rations at the beginning of the first experiment period (WS containing 74.1 % wheat midds and soybean hulls, and SC containing 75% shelled corn and 25% of 33% CP commercial protein supplement). Steers were allowed ad libitum access to water and grass hay. Treatment rations were fed once daily at 1600 h at .95% BW (wet wt. basis). Each experiment period was 17d with a 14-d adaptation period. On d 15, 3 Dacron bags containing 10g:bag were placed into the rumen of each steer at 0, 12, 24, 36, 48, 60 and 66h. All bags were removed at 72 h. Each time Dacron bags were placed into the rumen, rumen fluid was collected and pH analyzed. Feed samples were analyzed for OM, N, NDF, ADF, AIA and ash. Crude protein and HC were determined by calculation) N% $6.25 = CP$ and $NDF - ADF = HC$). WS contained 85.56% OM, 2.50% N, 15.63% CP, 68.34% NDF, 42.53% HC, 25.81% ADF, 19.99% cellulose, 0.14% AIA and 14.46% ash. The SC contained 95.16% OM, 2.46% N, 15.38% CP, 44.43% NDF, 38.72% HC, 5.81% ADF, 3.27% cellulose, 0.05% AIA and 4.84% ash. Rumen pH was similar between WS and SC ranging from 6.5 to 6.7. Rumen disappearance for OM and CP was not different ($P > 0.05$) between WS and SC at each time interval through 36 h of digestion comparing $59.83 \pm 12.90\%$ and $61.03 \pm 30.55\%$ and $72.18 \pm 21.17\%$ and $72.33 \pm 6.06\%$ at 36 h, respectively. Rumen disappearance for ADF and cellulose was not different ($P > 0.05$) between WS and SC by 72 h of digestion comparing $64.10 \pm 12.32\%$ and $63.86 \pm 22.27\%$ and $65.53 \pm 28.43\%$ and $63.54 \pm 27.17\%$, respectively. Rumen disappearance for OM, CP and NDF was greater ($P < 0.05$) by 72 h of digestion for SC than WS. The rumen digestibility of higher fiber rations containing wheat midds and soybean hulls appears similar to a ration lower in NDF and ADF.

Key Words: Wheat Midds, Soybean Hulls, Rumen Digestibility

M184 Effect of vitamin E and method of administration on performance and meat color of beef cattle. I. García^{*1}, R. Alderete¹, A. Alarcón¹, C. Rodríguez¹, J. Ortega¹, J. Pedraza², and O. Medina², ¹Facultad de Zootecnia, Universidad Autónoma de Chihuahua Periférico Fco. R. Almada km. 1.5 C.P. 31031. Chihuahua, Chih. México, ²Facultad de Química, Universidad Nacional Autónoma de México Cd. Universitaria, Del. Coyoacan, C.P. 04510. Distrito Federal, México.

The objective of the present study was to evaluate the effect of vitamin E (VitE) and the method of administration on performance of beef cattle and meat color. VitE was applied to thirty four crossed Charolais and Brangus heifers either by subcutaneous administration (SUB, 167 IU/a/d applied at 1, 30, 60 and 90 d of trial, n=16) or in finishing diet (DIE, 500 IU/a/d for 110 d, n=18); and a third group received no VitE and was taken as the control (CON, n=16). Animals were fed in pens and pen was the experimental unit. Performance parameters (body weight, BW; average daily gain, ADG; hot carcass weight, HCW; carcass yield, CY; and rib eye area, REA) as well as quality characteristics (color, L*, a*, b*; electrical conductivity, EC; water holding capacity, WHC) of packed meat were evaluated. A subsampling was done within experimental group (SUB n=9; DIE n=11 and CON n=10) to evaluate the effect of vitE on *L. dorsi* color during storage (4 C) for up to 28 d *postmortem* (3, 7, 14, 21 and 28 d). Thirty more *L. dorsi* steaks (one/subsampling animal) were aerobically packed (polyvinyl chloride PVC) and stored (4°C) for daily evaluation during 8 d. Variables evaluated during time (BW, ADG, color and WHC) were analyzed with PROC MIXED, considering the animal effect as random. HCW, CY and REA data was analyzed with PROC GLM of SAS. VitE administration method did not showed advantages ($P > 0.05$) on performance parameters. No difference ($P > 0.05$) in color and WHC of vacuum packaged steaks was observed among treatments. Likewise L* and b* values of PVC packaged steaks did not change ($P > 0.05$) among

treatments. However redness value (a*) of CON showed a linear tendency ($P < 0.05$) during storage, and the tendency for DIE and SUB was quadratic ($P < 0.05$). DIE and SUB had greater value ($P < 0.05$) than CON after day 4 (12.09 ± 0.43 and 11.43 ± 0.47 vs 10.28 ± 0.45) and DIE had greater value ($P < 0.05$) than SUB at days 7 and 8. VitE concentration ($\mu\text{g}/\text{mg}$ muscle) was higher for DIE (3.3 ± 0.4) than SUB (2.2 ± 0.5) and CON (1.3 ± 0.4). It is concluded that VitE applied subcutaneously or in feed improves color stability of aerobic packaged beef steaks.

Key Words: Vitamin E, Beef, Color Meat

M185 Effect of monensin on milk production, composition and body condition score of Murrah buffalo cows in early lactation. A. M. Jorge^{*1} and C. Andrighetto², ¹UNESP-FMVZ-DPEA-Botucatu, ²UNESP-FMVZ-PGZOO-Botucatu.

This experiment was carried out at the Buffaloes Production Area of the Unesp FMVZ Botucatu/SP/Brazil. Twenty four Murrah buffalo cows, were submitted to two treatments T1 (0 mg of monensin/buffalo cow/day) T2 (300mg of monensin/buffalo cow/day) evaluated on 150 first days of lactation. The total ration was composed by sorghum silage, elephant grass, and ration. The effect of monensin on milk production, milk composition and body condition score of buffaloes cows in early lactation. The milk control was done weekly, milk was collected for analysis of protein, fat and total solids were measured, the buffaloes cows was weighed and given body condition score. The design was completely randomised. There no statistical differences ($P > .05$) between treatments for daily milk production, total milk production, corrected for 270 days, milk production on peak of lactation, mozzarella production, percentage of protein, total solids, protein:fat ratio, weight and body condition score. Monensin influenced positively ($P < .05$) daily protein (T1 = 147.10 g, T2 = 162.07 g) and fat production, (T1 = 226.90g, T2 = 259.62g) and fat percentage (T1 = 5.41%, T2 = 5.84%).

Key Words: Ionophor, Lactation, Water Buffalo

M186 The effect of Acid Buf in dairy cow diets on production response and rumen parameters. C. W. Cruywagen^{*1}, J. P. Swieggers², S. J. Taylor³, and E. Coetzee⁴, ¹Department of Animal Sciences, University of Stellenbosch, Stellenbosch, South Africa, ²Bokomo Feeds, Malmesbury, South Africa, ³Celtic Sea Minerals, Carrigaline, Co. Cork, Ireland, ⁴Formufeed, Villiersdorp, South Africa.

A high concentrate TMR, formulated to be potentially acidotic, was used to construct five dietary treatments in which Acid Buf, the skeletal remains of the seaweed *Lithothamnium calcareum*, was included at increasing levels of 0.125, 0.3, 0.6, 0.9 and 1.2% of dietary DM. The response to Acid Buf included at the 0.3, 0.6 and 0.9% levels was measured using three groups of nine Holstein cows fed individually via Calan gates from calving to 70 DIM. Milk production was monitored daily and milk samples were taken weekly and analyzed for protein, fat and lactose. Cows were weighed and condition scored at 0, 28, 56 and 70 DIM. The response to Acid Buf at levels lower (0.125%) and higher (1.2%) than the main treatment levels was similarly measured but using group fed cows. Milk yield was adjusted by covariate analysis against initial performance. Adjusted average milk yield was 44.6, 41.4 and 39.3 liters/cow/day ($P < 0.05$) and efficiency of feed into milk was 1.83, 1.75 and 1.67 kg milk/kg feed for treatments containing 0.3, 0.6 and 0.9% Acid Buf, respectively. Adjusted milk output increased significantly ($P < 0.05$) as the Acid Buf inclusion was increased from 0.125 to 0.3% of DM but there was no significant effect on milk yield by increasing the level of Acid Buf from 0.9 to 1.2%. The five dietary treatments were also fed individually to five ruminally cannulated lactating Holstein cows in a latin square arrangement. Every cow received each diet for a period of 22 days prior to a collection period of 8 days. Rumen pH was monitored continuously every 10 minutes for 4 days using a portable data logging system and in-dwelling electrodes. Samples of rumen liquor were collected on two consecutive days, 2 hours before the morning feeding and again at 2, 6 and 10 hours after this feed allocation. Samples were analyzed for VFA and $\text{NH}_3\text{-N}$. The impact of feeding on rumen pH was clearly visible and increasing the dose of Acid Buf in the diet increased rumen pH throughout the period of measurement. However, the optimum dose of Acid Buf to optimize milk output and the efficiency of feed into milk was 0.3% of dietary DM or 80g/day.

Key Words: Acid Buf, Milk Production, Rumen Parameters

M187 Effect of malate supplementation on rumen fermentation and milk production in postpartum cows. M. Devant¹ and A. Bach^{*1,2}, ¹IRTA-Unitat de Remugants, Barcelona, Spain, ²ICREA, Barcelona, Spain.

A total of 38 Holstein cows were assigned to either Control or MALATE groups between 21 and 28 d prior to calving date to evaluate the effects of pre- and post-partum malate supplementation on rumen fermentation and milk production. Control cows (n=18) received a concentrate of 40% extruded corn, 30% soybean meal, 7.5% carob bean, 6.5% barley, 5% propylenglycol, 5% bypass fat, 3.45% sugar cane, 2.5% yeast, and, 0.05% binder. MALATE cows (n=20) received the same concentrate but yeast, and propylenglycol, and bypass fat were partially replaced by 4% of Rumalato (Norel& Nature, Spain) to provide 84 g/d of malate. Before calving, all cows were fed a TMR ad libitum and 1 kg/d of either MALATE or Control concentrate at a feeding station. After calving, cows were fed a TMR ad libitum and 1 to 3 kg/d of concentrate was gradually increased by 300 g/d. Milk production was recorded daily and milk composition monthly during the first 90 lactation days. Rumenocentesis was conducted 4 times for each cow at 7, 35, 63, and 90 d postpartum 4 hours after TMR delivery to determine rumen pH. A tendency (P = 0.096) in milk yield x week interaction was found. MALATE cows produced more milk at the 4th and 5th weeks postpartum than Control cows (37.1 and 38.4 kg/d vs 33.4 and 35.7 kg/d, respectively). Malate supplementation did not affect milk fat and protein contents (3.87 vs 3.67% and 3.15 vs 3.16%; Control vs MALATE, respectively). Mean rumen pH was not affected by treatment (P > 0.05; 6.19 vs 6.28, Control vs MALATE, respectively). Ruminal pH at 7d postpartum was lower (P = 0.08) than at 36, 63, 91 d postpartum (6.11, 6.19, 6.23, and 6.41, respectively). Mean concentrate intake was greater in MALATE than in Control cows (P < 0.05; 2.23 vs 1.96 kg/d, respectively). Although cows supplemented with malate consumed more concentrate, rumen pH did not decrease, indicating that malate may effectively prevent rumen acidosis. Also, supplementation of malate may result in increased milk production during peak of lactation.

Key Words: Malate, Milk, Rumen

M188 The effect of an inoculant containing *Lactobacillus buchneri* 40788 on fermentation and aerobic stability of corn silage at two packing densities. M. Antoniali¹, O. C. M. Queiroz², R. J. Schmidt^{*3}, and L. Kung, Jr³, ¹Universidade Estadual Paulista Jaboticabal, SP Brazil, ²Universidade de Sao Paulo Piracicaba, SP, Brazil, ³University of Delaware, Newark.

Whole-plant corn was harvested at 1/3 milcline (38% DM) and packed in 20-L laboratory silos to investigate the effects of inoculation and packing density on silage fermentation. Treatments were: 1) untreated forage, tightly packed at 241 kg DM/m³ (15 lb/ft³); 2) forage inoculated with *L. buchneri* 40788 (400,000 cfu/g of forage) and *Pediococcus pentosaceus* (100,000 cfu/g) (Lallemand Animal Nutrition, Milwaukee, WI), tightly packed; 3) untreated forage, loosely packed at 194 kg DM/m³ (12 lb/ft³); and 4) inoculated and loosely packed. The experimental design was a 2 x 2 factorial arrangement of treatments. The effects of packing density, inoculation, and their interactions were tested. The results are detailed in the table below. After 60 d of ensiling, treatments had no effects on silage pH. Silages that were loosely packed had more acetic acid (P < 0.05) and unexplainably more lactic acid bacteria (LAB) (P < 0.05) than did silages that were tightly packed. Inoculation, regardless of packing density, resulted in silages with higher concentrations of acetic acid (P < 0.05) and lower lactic:acetic acid ratios (P < 0.05), lower concentrations of water soluble carbohydrates (WSC) (P < 0.05), and fewer yeasts and molds (P < 0.05). The results of this study show that application of an inoculant containing *L. buchneri* 40788 is effective at improving the aerobic stability of corn silage under a variety of packing densities.

Item	Loose pack		Tight pack		S.E.	Effects ³
	Untreated	Inoculated	Untreated	Inoculated		
Lactic acid, %	4.64	4.29	4.41	4.53	0.23	
Acetic acid, %	1.69	2.23	1.60	2.08	0.04	I, P
Lact:Acet ratio	2.74	1.92	2.75	2.18	0.06	I
WSC, %	1.40	0.97	1.26	0.82	0.21	I
LAB ²	6.80	8.70	6.68	8.58	0.23	I, P
Yeasts ²	3.92	2.70	4.05	1.66	0.67	I
Molds ²	3.97	2.57	3.73	1.81	0.72	I
Stability ³ , h	27.5	34.5	31.0	60.0	7.10	I

¹Effect of I = inoculant or P = pack density, P < 0.05,

²log₁₀ cfu/g,

³Hours before a 2°C rise in temperature after exposure to air

Key Words: Aerobic Stability, *Lactobacillus buchneri*, Silage

M189 Effect of feeding *Aspergillus oryzae* fermentation culture to lactating dairy cows on milk yield, composition, and rumen fermentation. T. Sato*, T. Takano, and K. Murata, ZENNOH National Federation of Agricultural Co-operative Associations 1708-2 Tsukuriya Tsukuba Ibaraki, Japan.

The objective of this study was to evaluate the effect of feeding *Aspergillus oryzae* fermentation culture (AO) on the performance of lactating dairy cows and rumen fermentation. Twelve multiparous Holstein cows between 40-130 days in milk and three ruminally cannulated lactating cows were randomly assigned to one of three treatments: 1) Control, 2) Control + 25g/head/d (AO1), and 3) Control + 50g/head/d (AO2). Cows were housed in a tie-stall barn for the duration of the experiment and individually fed for ad libitum intake twice a day at 0800 and 1700 h. The experiment followed a 33 Latin square design with three 21-day periods. Samples and data were collected during the final 7 days of each period. The TMR (DM basis) were 46:54 forage:concentrate for all treatments. The main dietary ingredients were alfalfa-hay, timothy-hay, ground corn, whole cottonseed, beet pulp, soybean meal and Japanese commercial supplement. The control TMR was balanced using CPM Dairy (version 3.0.4a). The respective levels of AO product were mixed in the TMR and purchased from Nichimo Co., Ltd. (Tokyo, Japan). Feeding AO to lactating dairy cows improved milk production and lactose % in milk. Milk production (kg/d) was higher (P<0.05) in AO1 and AO2 than control (33.4, 34.1 and 32.2). Lactose (%) and % solid not fat (SNF) in AO2 was higher (P<0.05) than control (4.6, 4.55; and 8.86, 8.74; respectively). Ruminal pH and volatile fatty acids of rumen fluid (mM) from 2 to 4 h after feeding were higher for AO1 and AO2 than control (6.3, 6.4, 6.0; and 120.9, 121.4, 105.9). There were no treatment differences in dry matter intake, milk fat % and yield, milk crude protein %, milk urea nitrogen, and somatic cell counts. In conclusion, feeding *Aspergillus oryzae* fermentation culture to dairy cows altered rumen parameters at 2 and 4 h postfeeding which may explain the increase in milk yield realized from feeding AO at both 25g and 50g/head/d.

Key Words: Dairy Cow, *Aspergillus oryzae*, Rumen Fermentation

M190 Effect of live yeast *Saccharomyces cerevisiae* on milk production, quality and health status of Saanen dairy goats. R. Paratte^{*1}, A. Stella¹, G. Cigalino¹, G. Soncini¹, L. Valnegri¹, E. Chevaux², G. Savoini¹, and V. Dell'Orto¹, ¹Dept. of Vet. Sci. Tech. Food Safety, University of Milan via Celoria, 10 Milano-Italy, ²Lallemand SA rue de Brequetiers, 19 Blagnac Cedex-France.

The effect of a live yeast supplement in dairy goats has been examined in a limited number of studies. While the yeast culture does contain some viable cell, the yeast live cell supplement contain higher numbers of 100% active *Saccharomyces cerevisiae* (SC). 57 Saanen dairy goats were utilized to investigate the effects of the supplementation of SC during the first half of lactation. Goats were assigned according to parity and milk production during the first three weeks of lactation in two groups. All goats were fed a total mixed ration (TMR) containing 40% commercial concentrate, 28% triticale silage, 22% hay, 10% dried beet pulp. Treatments lasted for 15 weeks starting from week 3 of lactation and were: control (C)-TMR; (SC)-TMR mixed with 0.2g of SC (4x10⁹ CFU/g, Levucell SC20). DMI, BCS and milk yield were recorded for 126d postpartum with milk samples analysed weekly for fat, protein, lactose, urea and SCC. Blood samples were analysed monthly for urea, glucose, BHBA, NEFA, GOT/AST and GGT. In order to monitor intestinal microflora, faeces were monthly analysed for total bacterial load, enterobacteria,

E. coli, coliforms, lactic bacteria, clostrides, moulds, yeasts. BCS, DMI and milk yield (C: 2.23Kg±0.04; SC: 2.37Kg±0.02) were positive affected by the treatment (P<0.05). Milk fat content was lower and milk urea content was higher in treated goats (P<0.05). Plasma metabolites were similar among treatments. NEFA was not affected by the treatment, although there was a non significant trend toward lower values in the treated animals (P=0.06). SC did not affect liver functionality, AST/GOT and GGT were similar among treatments. *E. coli* faeces content was positively reduced (C: 2.39; SC: 0.72; log10 CFU/g, SE 0.25) by the treatment where lactic bacteria content was significantly higher (P<0.001). Yeast in the faeces was confirmed by the microbiological analyses (P<0.001). SC increased milk yield and reduced *E.coli* in faeces.

Key Words: Live Yeast, Dairy Goat

M191 Dose response of a direct-fed microbial on milk yield, milk components, body weight, and days to first ovulation in primi- and multiparous Holstein cows. D. R. Stein¹, D. T. Allen¹, K. W. Gates¹, T. G. Rehberger², K. J. Mertz², D. A. Jones¹, and L. J. Spicer¹, ¹Oklahoma State University, Stillwater, ²Agtech Products, Inc., Waukesha, WI.

From 14 d before parturition to 175 d postpartum, 38 primi- (pp) and multiparous (mp) Holstein cows were blocked by expected milk production and randomly assigned to treatment groups: Control, n=13, received a total mixed ration (TMR); Low treatment, n=11, received control TMR plus Low dose (1X/head/d) of Propionibacterium strain P169 (P169); High treatment, n=14, received control TMR plus High dose (10X/head/d) of P169. Rumen fluid was collected at -14d, +60d, +120d, and +175 d of lactation. Milk samples were collected twice weekly and analyzed for milk components. Daily milk production (4% fat-corrected milk; FCM) was influenced by treatment (P < 0.01) such that FCM (averaged across pp and mp cows) was greater (P < 0.05) in the High (32 ± 0.5 kg/d) and Low (33 ± 0.5 kg/d) P169 vs Control (30 ± 0.5 kg/d) cows; FCM did not differ between the High and Low P169 groups. Milk lactose was affected by treatment x age (P < 0.03) with High P169 pp and mp cows having a higher percentage lactose (5.04 and 5.10 ± 0.04 %, respectively), than the Low P169 pp and mp cows (4.89 and 4.91 ± 0.04 %, respectively) or the Control pp and mp cows (4.93 and 4.77 ± 0.04 %, respectively). Weekly body weights (BW) from wk 1 to 25 were greater (P < 0.05) in High P169 mp cows (635 ± 18 kg) than Low P169 (604 ± 16 kg) and Control (601 ± 17 kg) mp cows. BW in pp cows (528 ± 13 kg) did not differ (P > 0.10). P169 treatments influenced the fold differences of rumen propionate (P < 0.05) which were greater in High P169 (5.69 ± .70) vs Low P169 (2.91 ± .65) and Control (2.74 ± .62) groups at 60,120, and 175 d. No main effects or interactions were found for days to first ovulation (progesterone conc. greater than or equal to 1.0 ng/ml). We conclude that P169 may hold potential as an effective direct-fed microbial to increase milk production.

Key Words: Propionibacteria, Milk Yield, Direct-Fed Microbial

M192 Effect of forage to concentrate ratio on B-vitamins in different ruminal fractions. D. E. Santschi¹, R. Berthiaume², R. Martineau³, J. J. Matte², A. F. Mustafa¹, and C. L. Girard², ¹McGill University Ste-Anne-de-Bellevue, Qc, Canada, ²Dairy and Swine R&D Centre Lennoxville, Qc, Canada, ³Universite Laval, Qc, Canada.

Six ruminally caulked lactating Holstein cows (78 ± 13 DIM) were used in a cross-over design to evaluate the effects of forage to concentrate ratio on B-vitamin concentrations in ruminal contents. Diets were formulated to have forage to concentrate ratios of 60:40 (high-forage, HF) and 40:60 (low-forage, LF), and contained respectively (DM basis) 43.0 and 23.5% mixed silage, 16.9 and 16.4% corn silage, 28.4 and 40.0% high moisture corn, 4.0 and 8.6% soybean meal, 5.3 and 8.6% protein supplement, and 2.3 and 2.7% mineral and vitamin premix (without B-vitamins). Rations were fed as a TMR in 12 daily meals (at 95% of the ad libitum DMI of the HF diet). Ruminal samples (250 g of solid and 1.23 L of liquid material) were collected at the end of each 4-wk adaptation period and ruminal fractions were separated (1989. Br. J. Nutr. 61:725). B-vitamins were analyzed in the particle-free fluid (PFF) and in the freeze-dried liquid- and solid-associated bacteria (LAB and SAB). B-vitamin concentrations were similar for LAB and SAB, and were 125 to 5000 times higher than in PFF. The concentrations of B-vitamins in SAB were as follows for the HF and LF diet respectively:

riboflavin (40.51 vs 47.79 µg/g; P=0.01), pyridoxamine (7.04 vs 9.05 µg/g; P=0.06), pyridoxine (0.95 vs 0.63 µg/g; P≤0.01) and true B12 (4.00 vs 3.08 µg/g; P≤0.01). The HF diet also yielded higher concentrations of true B12 in the LAB fraction (6.34 vs 4.75 µg/g; P=0.07) and of pyridoxine (98.62 vs 57.15 ng/ml) and biotin (24.32 vs 18.53 ng/ml) in the PFF (P≤0.04). Therefore, B-vitamins were present mainly in the bacterial fractions of the rumen while only limited amounts were found in the surrounding fluid. A change in the forage to concentrate ratio had a greater effect on vitamin synthesis by the bacteria associated to the solid fraction than by those present in the liquid portion of the rumen. In conclusion, it appears that ruminal B-vitamin synthesis is altered by changes in the forage to concentrate ratio, which suggests that the supply of vitamins to dairy cows is influenced by the diet composition.

Key Words: Cow, B-Citamins, Forage:Concentrate Ratio

M193 A statistical evaluation of early- or mid-lactation dairy cow responses to dietary sodium bicarbonate. W. Hu* and M. R. Murphy, University of Illinois, Urbana.

Our objectives were to examine, using mixed model statistical analysis, effects of dietary NaHCO₃ on the performance of early- or mid-lactation dairy cows and to determine if an optimal amount of buffer inclusion exists for these cows. A database was developed from 27 studies published between 1980 and 1999 that included a total of 30 trials, 73 dietary treatments, and 369 cows. Dietary NaHCO₃ was categorized according to amount in the diet as control (0%), moderate (0.70 to 1.0%), or high (1.05 to 1.5%); NaHCO₃ concentrations outside these ranges were not included. Forage type was categorized as corn silage (CS) when it was the sole or main dietary forage or as forage other than CS (NCS) when alfalfa hay, or silages based on alfalfa, barley, sorghum, triticale, or wheat were the sole or main dietary forages. The statistical model included the fixed effects of buffer concentration and forage type, and the random effect of study. Dry matter intake did not differ among buffer treatments for cows fed NCS; however, cows fed CS without NaHCO₃ addition consumed 1.24 kg/d less dry matter (P < 0.02) than cows fed buffer. Intake was not affected in cows fed CS with dietary NaHCO₃. Milk production, milk protein percentage, and protein yield were unaffected by buffer treatments regardless of forage type; however, milk fat percentage of cows fed CS-based diets was 0.27 percentage units higher when NaHCO₃ was included (P < 0.02). The 4% fat-corrected milk was also higher for buffered compared to unbuffered diets, by 1.86 kg/d (P < 0.02). Addition of NaHCO₃ at 0.70 to 1.0% of dietary dry matter, based on contrast analyses, appeared optimal for early- or mid-lactation cows fed CS-based diets. Forage type was confounded with acid detergent fiber content of the diet; therefore, differences in response to buffer treatments related to forage type might be explained by variation in the fiber contents of the forages themselves.

Key Words: Sodium Bicarbonate, Performance, Dairy Cows

M194 Fate of supplemental B-vitamins in the gastrointestinal tract of dairy cows. D. E. Santschi¹, R. Berthiaume², J. J. Matte², A. F. Mustafa¹, and C. L. Girard², ¹McGill University Ste-Anne-de-Bellevue, Qc, Canada, ²Dairy and Swine R&D Centre, Lennoxville, Qc, Canada.

Four lactating Holstein cows equipped with ruminal, duodenal (30cm from pylorus) and ileal (60cm from ileo-cecal valve) canulae were used to evaluate disappearance of supplemental B-vitamins in the rumen and the small intestine. Cows were fed a TMR with chromic oxide in 12 daily meals. Each study consisted of a control (Ctrl; no vitamins) and a vitamin supplementation period (Trt). Daily amounts (mg) for studies 1 and 2 were respectively: B1:300,15; B2:1600,1.6; B6:800,40; B9:2600,130; B12:500,0.5. In study 1, vitamins were added to the feed 5 days prior to and during the 4 collection days. In study 2, vitamins were infused post-ruminally one day prior to and during the 4 collection days. Disappearance prior to the small intestine was calculated as the amount of vitamins appearing at the duodenum relative to the quantity given. Intestinal disappearance was calculated as the amount disappearing between the two intestinal canulae compared with the amount arriving at the duodenum. Important ruminal disappearance was noted in study 1 (68% B1, 99% B2, 41% B6, 97% B9 and 63% B12), but there was almost no disappearance of post-ruminally infused vitamins prior to the duodenum, confirming that extensive destruction occurs in the rumen. The negative intestinal disappearance for B9 during the control periods

suggested extensive recycling of this vitamin (probably through the enterohepatic cycle), leading to underestimation of the true disappearance rate. The proportion of vitamins disappearing from the small intestine was not decreased by supplementation ($P \geq 0.09$). For all vitamins but B2 in study 1, absolute amounts being absorbed were greater during the Trt than the Ctrl periods, suggesting that B-vitamin supply in dairy cows is increased by supplementation, although losses in the rumen are extensive.

Vitamins	Study 1			Study 2		
	% Disappearance	% Disappearance	P	% Disappearance	% Disappearance	P
B1	77 (7)	55 (13)	0.09	73 (6)	67 (5)	0.47
B2	35 (3)	36 (4)	0.88	37 (4)	37 (4)	0.79
B6	46 (12)	88 (2)	0.09	50 (14)	72 (2)	0.23
B9	neg	10 (5)	-	neg	16 (5)	-
B12	11 (4)	15 (4)	0.40	11 (2)	16 (7)	0.55

Mean (SEM)

Key Words: Cow, B-Vitamins, Gastrointestinal Tract

M195 Ruminal degradability of nitrogen, phosphorus, and potassium from dairy feedstuffs. A. N. Hristov^{*1}, A. Melgar¹, A. E. Foley¹, and R. Kincaid², ¹Department of Animal and Veterinary Science, University of Idaho, Moscow, ²Department of Animal Sciences, Washington State University, Pullman.

The objective of this study was to determine ruminal degradability parameters of nitrogen (N), phosphorus (P), and potassium (K) from feedstuffs common in Northwest dairy diets. Alfalfa hay (AA), corn silage (CS), and whole cottonseed (WCS) were oven dried and ground through a 2-mm sieve. Barley grain (BG), corn grain (CG), and whole soybeans (SB) were coarsely ground. All feeds were sieved through a 100-mm screen and particles retained on the sieve were incubated *in sacco* in the rumen of three lactating dairy cows for up to 72 h. Ruminal microorganisms were labeled through a continuous intraruminal infusion of $(^{15}\text{NH}_4)_2\text{SO}_4$; ^{15}N was used to correct the nylon bag residues for microbial (N, P, K) contamination. The soluble/instantly degradable fraction of N was greatest ($P < 0.05$) for CS ($82.9 \pm 1.76\%$) and lowest ($P < 0.05$; except *vs.* BG) for CG ($6.5 \pm 2.05\%$). Alfalfa hay and WCS had the greatest ($P < 0.05$) rates of N degradation (13.4 ± 2.28 and $14.9 \pm 3.07\%$ /h, respectively). Alfalfa hay, CS, and WCS had the greatest ($P < 0.05$) effective degradability (ED) of N (82.3 ± 1.08 , 87.5 ± 1.09 , and 82.2 ± 1.06 , respectively). P was very soluble in AA, CG, CS, and WCS (from 63.0 ± 11.2 , $97.0 \pm 5.48\%$, CS), but not BG and SB. Rates of P degradability did not differ ($P > 0.05$) among feedstuffs. ED of P were: 93.0 ± 4.26 , 58.0 ± 4.65 ($P < 0.05$), 83.8 ± 4.26 , 97.8 ± 4.15 , 76.3 ± 7.14 , and $92.1 \pm 4.24\%$ (AA, BG, CG, CS, SB, and WCS, respectively). Solubility of K in AA, BG, SB, and WCS was 98.5 ± 1.53 , 62.7 ± 1.66 , 60.0 ± 1.59 , and $92.6 \pm 0.99\%$, respectively. ED of K was high for all feedstuffs (from 94.0 ± 0.59 , BG to $99.7 \pm 0.67\%$, AA). Although the K degradation parameters for CG and CS could not be estimated, K solubilities were 94 and 99%, respectively. Ruminal degradability of N varied, but P and K were very soluble and rapidly degradable in most of the feedstuffs studied.

Key Words: Nitrogen, Phosphorus, Potassium

M196 Effects of a fibrolytic enzyme formulation on forages, co-products, and byproducts fermented *in vitro*. K. F. Wilson^{*1}, G. V. Pollard², and C. R. Richardson³, ¹Animal Feed Technologies, Greeley, CO, ²Texas State University, San Marcos, ³Texas Tech University, Lubbock.

The effectiveness of enzymes in animal feeding has been well proven, however, due to the constant influx of new co-products and byproducts the affects of enzyme formulations on these ingredients are unknown. Therefore, an *in vitro* dry-matter digestibility study was designed to determine the effect of Cattle-AseTM C on a broad spectrum of forages, co-products, and byproducts. The feedstuffs evaluated were alfalfa, wheat straw, sorghum sudan grass, almond hulls, corn cobs, cotton moats, peanut hulls, rice hulls, soy hulls, beet pulp, corn/barley middlings, distillers grains, wheat middlings, and sweetbranTM and ranged

broadly in chemical analysis and fiber level. Alfalfa, cellulose, cornstarch, and ground corn were used as indicator ingredients to the evaluated feedstuffs. Dry-matter disappearance was evaluated utilizing the Moore modification of the two-stage Tilley-Terry procedure at incubation times of 24 h and 48 h. A 0.7 g sample of ingredient was combined with 50-mL of buffer and rumen fluid mixture and placed in a 39°C water bath for the predetermined incubation times. Results showed that at 24 h, Cattle-Ase improved ($P < 0.10$) dry-matter digestibility for the higher fiber ingredients such as sorghum sudan grass, almond hulls, corn cobs, cotton moats, soy hulls, and corn/barley middlings. On average for the 24 h period, Cattle-Ase improved digestibility by 31.6%. The only difference ($P < 0.10$) observed at 48 h was for sweetbran. On average for the 48 h period Cattle-Ase only improved digestibility by 7.7%. The likely attributing effect to Cattle-Ase not improving ($P > 0.10$) digestion at 48 h treatment would be a loss of fermentable energy associated to these types of feedstuffs. In previous experiments, Cattle-Ase improved *in vitro* dry-matter digestibility across times and feedstuffs by over 20%. Therefore, these results substantiate the benefit of including enzymes in a feeding regime in which products containing higher fiber levels are used.

Key Words: Fibrolytic Enzymes, Co-Products, Byproducts

M197 Effects of fibrolytic enzymes and fat supplementation on fiber digestibility, nitrogen metabolism and fermentation profile in continuous culture system. A. Bouattour, L. Castillejos, R. Casals, S. Calsamiglia^{*}, and E. Albanell, *Universitat Autònoma de Barcelona*.

Eight dual flow continuous culture fermenters (1320 mL) were used in a 2x2 factorial design in two consecutive periods of 8 days (5 for adaptation and 3 for sampling) to study the effects of an exogenous fibrolytic enzyme (E: 0 vs 2 ml/kg DM) complex (Promote[®], Agribrands International) and sunflower oil (SF: 0 vs 28 g/kg DM) on rumen microbial fermentation and nutrients digestibility. The enzyme was sprayed on the forage and immediately dried at 55°C for 48 h, and the non enzyme treatments were sprayed with water and processed identically. Diets (95 g DM/d of a 60 to 40 forage to concentrate ratio, 17.9% CP, 42.2% NDF) were fed in three equal amounts along the day. Fermentation conditions (temperature = 39°C, pH = 6.4, and liquid = 10%/h and solid = 5%/h dilution rates) were maintained constant. Effluent samples were taken from a composite of the three sampling days, and bacteria were isolated from fermenter flasks on the last day of each period for chemical analysis. There were no effects of E on true digestion of OM (47.5%), NDF (38.5%), and ADF (43.3%). Fat digestibility increased ($P < 0.0001$) from 32.1 to 52.4% in SF treatment and decreased ($P < 0.05$) from 46.3 to 38.2% in E treatment. The SF decreased ($P < 0.01$) the total VFA concentration (mM) from 103.4 to 95.4 and E decreased ($P < 0.025$) it from 102.8 to 95.9. There was an E by SF interaction for butyrate ($P < 0.038$) and isobutyrate ($P = 0.068$) proportions. Ammonia N concentration (9.72 mg N/dL), the flow (g/d) of total N (3.04), ammonia N (0.31), non ammonia N (2.74), bacterial N (1.00), and dietary N (1.74), CP degradation (33.4%), and efficiency of microbial protein synthesis (23.3 g N/kg OM truly digested) were not affected by dietary treatments. The use of fibrolytic enzymes and sunflower oil decreased the concentration of total VFA but did not affect fiber digestion. Acknowledgment: financial support from CICYT-Spain (project AGL-2001-2617).

Key Words: Fibrolytic Enzymes, Sunflower Oil, Rumen Fermentation

M198 Effects of fibrolytic enzymes on *in vitro* ruminal degradation and gas production of alfalfa hay. J.-S. Eun^{*1}, S.-H. Hong², K. Beauchemin¹, and M. Bauer³, ¹Agriculture and Agri-Food Canada, Lethbridge, AB, Canada, ²Sahmyook College, Cheongnyangni, Seoul, Korea, ³Syngenta Biotechnology Inc., Research Triangle Park, NC.

A series of recombinant, single activity enzyme products (supplied by Zymetrics, MN), including 13 cellulases (END) and 10 xylanases (XY), were evaluated for their potential to improve ruminal degradation of forages *in vitro*. Enzyme activities were determined at pH 5.3-5.4 and 37°C using 1.0 to 1.4% substrate (arabinoxylan from wheat for endoxylanase and beta-glucan from barley for glucanase; Megazyme, Ireland). Based on these enzyme activities, a dose level (1000 U/kg) was chosen for the addition of enzymes. One gram of alfalfa hay DM was weighed into fermentation bottles (125 mL capacity). Because the enzyme products were freeze-dried, they were resuspended by adding H₂O, and then the

enzyme solution was added to the corresponding bottles in 6 replications. Forty milliliters of anaerobic buffer medium adjusted to pH 6.0 was added to the bottles. The strained ruminal fluid was inoculated into culture bottles and incubated for 18 h. Headspace gas produced by substrate fermentation was measured at 2, 6, 12, and 18 h post inoculation. Apparent OM degradation (OMD) was determined after 18 h of incubation. Data were analyzed using the Proc Mixed procedure of SAS 8.1. Total gas production measured at the end of incubation (18 h) was higher ($P < 0.05$) for most of the END (except for END A and END C) compared with the control (alfalfa without enzyme). Addition of END increased ($P < 0.05$) OMD (except for the same 2 END products). Total gas production and OMD were increased by 5 XY enzymes, but these were not the same XY products in each case. Increases in OMD ranged from 5.4% to 14.1% and from 5.6% to 16.3% for the END and XY enzymes, respectively. Addition of END or XY decreased the partitioning factor of fermentation calculated as mg OM degraded/mL gas produced. In summary, some of the pure END and XY enzymes we tested increased in vitro degradation of alfalfa hay, and they greatly influenced partitioning of fermented substrate.

Key Words: Cellulases, Xylanases, In Vitro Degradation

M199 Ranges of optimal cellulase activity of commercial fibrolytic enzyme preparations used in ruminant diets. E. González*, E. Albanell, G. Caja, and R. Casals, *Grup de Recerca en Remugants, Departament de Cincia Animal i dels Aliments, Universitat Autònoma de Barcelona, Bellaterra, Spain.*

An in vitro study was conducted to investigate factors by which cellulase activity of fibrolytic enzyme preparations for ruminants are affected. Two liquid commercial enzyme products, Promote (PRO) and Cellupract AL 100 (CEL), both isolated from aerobic fungus (*Trichoderma longibrachiatum* and *Trichoderma reesei*) and with recognized cellulase activity, were used to examine the effects of pH, temperature, enzyme dose, and its interactions. Cellulase activity was determined in a factorial design (3 × 4 × 3) for three pH (4.0, 5.5 and 6.5), four temperatures (30, 40, 50 and 70 C), and three doses (1, 2 or 3 g/kg DM of substrate). Average and extreme values for experimental treatments were selected according to practical criteria either for current ruminal or industrial conditions. Carboxymethyl cellulose (CMC) was used as substrate, and concentrations of reducing sugars were determined in absence of ruminal liquor by the Nelson-Somogyi copper reduction method with glucose as standard. There were no significant differences for the average enzymatic activities between products (561 and 631 μmol of released sugar $\text{min}^{-1} \text{g}^{-1}$ for CEL and PRO, respectively). Cellulolytic activity was highly affected ($P < 0.001$) by pH, temperature, and enzyme doses, as well as by pH × temperature and pH × temperature × doses interactions. Maximum cellulolytic activities were obtained for pH 4.0, temperature 50C and the greatest dose (3 g/kg DM) on average (854, 2047 and 905 μmol of released sugar $\text{min}^{-1} \text{g}^{-1}$ of the enzyme applied, respectively). Optimal interactive cellulolytic activities were obtained for the sets pH 4.0-50C, and for pH 4.0-50C, with an enzyme dose of 3 g/kg DM (2931 and 4608 μmol of released sugar $\text{min}^{-1} \text{g}^{-1}$ of the enzyme applied, respectively). Optimal conditions for commercial enzyme products evaluated in this experiment, demonstrated to be out of the normal ranges in ruminal environment.

Key Words: Fibrolytic Enzymes, Cellulase Activity

M200 Effects of a supplemental amylase enzyme preparation on lactational performance in commercial dairy herds. 1. Whole herd responses. G. A. Harrison* and J. M. Tricarico, *Alltech Biotechnology, Inc., Nicholasville, KY.*

Field trials with a supplemental amylase preparation (AmaizeTM, Alltech Biotechnology Inc., Nicholasville, KY) were conducted during 2002 and 2003 in 45 commercial dairy herds across the U.S. and Canada (approximately 8150 cows). Number of cows, days in milk, milk production and composition were collected from two consecutive monthly Dairy Herd Improvement (DHI) test records. Fat-corrected (FCM) and energy-corrected milk (ECM) were calculated from milk yield and composition measurements. Herds began receiving supplemental amylase after the first monthly DHI test. The amylase preparation was added to the base herd ration at the rate of 12 grams/head/day. Cows were fed supplemental amylase, on average, for 26 d before the second monthly DHI test. Response to enzyme supplementation was evaluated using a Students t-test on the difference obtained by subtracting the second

from the first monthly test. The null and alternate hypotheses were the difference equals zero or greater than zero, respectively. Data were weighted by herd size. Milk yield was greater during the enzyme treatment test period (32.0 vs 31.7 kg, $P=0.059$) when data from all 45 herds were included in the analysis. The dataset included twelve trials conducted with herds in the Southeastern U.S. in the summer of 2002 during severe heat stress. When data from all herds with an initial DHI test in June or July of 2002 were excluded (leaving 32 herds in the dataset), amylase supplementation increased milk yield (32.8 vs. 31.8 kg, $P=0.001$), FCM yield (34.3 vs. 33.7 kg, $P=0.072$), ECM yield (33.8 vs. 33.1 kg, $P=0.051$), and milk protein yield (1.02 vs. 0.99 kg, $P=0.014$). In addition, milk fat percentage was reduced (3.80 vs. 3.87, $P=0.037$) but milk fat yield was not affected by amylase supplementation in those 32 herds. Amylase supplementation increased milk yield in 56% of the herds when data from all herds were included in the analysis and increased milk yield in 72% of the herds when data from summer 2002 trials were excluded.

Key Words: Amylase, Dairy Cows, Field Study

M201 Effect of a supplemental amylase enzyme preparation on lactational performance in commercial dairy herds. 2. Individual cow responses. G. A. Harrison* and J. M. Tricarico, *Alltech Biotechnology, Inc., Nicholasville, KY.*

Individual cow data from field trials with a supplemental amylase preparation (AmaizeTM, Alltech Biotechnology Inc., Nicholasville, KY) conducted during 2002 and 2003 in 12 commercial dairy herds were included in this summary. Days in milk (DIM), milk production, and composition were collected from downloaded Dairy Herd Improvement (DHI) test records. Fat-corrected (FCM) and energy-corrected milk (ECM) were calculated from milk yield and composition measurements. The dataset included 1079 cows with three consecutive DHI tests and initial DIM>60. Herd was used as the experimental unit and weighted herd means were used in the analysis. Amylase was added to the base herd ration at the rate of 12 grams/head/day. Herds began receiving supplemental amylase after DHI test 1. Diets containing amylase were fed for an average of 24 days prior to DHI test 2. Amylase was removed from the diets after test 2 and the base diets (no amylase) were fed for an average of 22 day prior to DHI test 3. The response to amylase supplementation was evaluated by a contrast between test 2 (amylase) and tests 1 and 3 (no amylase) as described by McGillard and Stallings, 1998 (J. Dairy Sci. 81:1353). Predicted milk yield and composition for test 2 were calculated based on test 1 and 3 measurements adjusted for changes in DIM. For test 2, actual milk was greater than predicted milk yield (33.3 vs. 32.2 kg, $P=0.101$) while actual milk fat percentage was lower than predicted (3.77 vs. 3.90, $P=0.013$). Actual milk protein percentage, FCM, and ECM were not different from predicted, though actual milk protein yield did tend to be higher than predicted (1.03 vs. 1.00 kg, $P=0.153$). Summarizing individual cow records yielded comparable results to the whole herd summary. In cows greater than 60 DIM, actual milk was 1.1 kg greater than predicted milk based on the increase in DIM. Actual milk fat percentage was lower than predicted, but the increase in milk yield resulted in similar fat and numerically greater protein yields.

Key Words: Amylase, Dairy Cows, Field Study

M202 Effect of increased residual water-soluble carbohydrate concentration in ryegrass silage on intake, milk production, and N excretion in dairy cows. J. M. Moorby*, W. J. Fisher, and R. T. Evans, *Institute of Grassland and Environmental Research, Aberystwyth, UK.*

To study the effects of increased residual water-soluble carbohydrates (WSC) in grass silage, 16 multiparous mid-lactation Holstein-Friesian dairy cows were offered one of two ryegrass silages ($n = 8$ per treatment) over 2 consecutive 7 wk periods (wk 8-14 and 15-21 of lactation). During each period silages made from a high WSC variety of ryegrass (HS; var. AberDart) or a control ryegrass (var. Fennema) were compared, offered ad libitum with 5 kg/d concentrates. In period 1 (P1) the two silages were second cuts, while in period 2 (P2) the silages were third cuts. Four cows per treatment underwent whole-body N partitioning and feed digestibility measurements for 6 d in the last week of each period. Silage DM was similar for both varieties during each period (means of 25% for P1 and 23% for P2). WSC was higher ($P<0.05$) in HS silage fed during P1 (2.4% vs 1.7% of DM), but not in P2. Crude

protein was higher ($P < 0.05$) in HS silage in both periods (18.2% vs 17.3% in P1, and 17.7% vs 16.9% in P2). In P1 feed DMI and milk yields were similar for both diets (means of 17.3 kg DMI/d and 27.8 kg milk/d). In P2 DMI was higher ($P < 0.05$) for cows fed the HS diet (16.2 vs 15.0 kg/d), but milk yields were similar (mean 22.5 kg/d). Milk fat concentrations and yields of cows fed HS were higher ($P < 0.05$) in both periods. Milk protein concentrations were also higher on the HS diet in both periods, but protein yields were only higher ($P < 0.05$) in P2. In P1, cows given the HS diet with higher WSC excreted a lower ($P < 0.05$) proportion of their feed N in urine, but in P2 when the HS silage had similar WSC content to control, urine N excretions were similar. In P1, feed whole-tract digestibility was similar for both diets, but in P2 it was higher ($P < 0.05$) for the control diet. Although differences in silage WSC content were small, it is concluded that when cows are fed ryegrass silages containing higher concentrations of WSC they yield milk with improved composition and partition less of the dietary N to urine.

Key Words: Dairy Cows, Grass Silage, Water-Soluble Carbohydrates

M203 An evaluation of FuzZPellet™ whole cottonseed product on milk production in post-peak Holstein cows. P. A. Porter^{*1}, N. L. Scott¹, and R. B. Harding², ¹Land O'Lakes Inc., Gray Summit, MO, ²Buckeye Technology, Memphis, TN.

Thirty-nine (29 multiparous, 10 primiparous) Holstein cows, approximately 110 DIM at trial initiation, were assigned to either WCS (10% of the ration DM as whole cottonseed) or FuzZ (10% of the ration DM as pelleted cottonseed product, FuzZPellet™, Buckeye Technology, Memphis, TN) diets in an 8-wk randomized complete block design. On a DM basis, the ration contained 34% corn silage, 23% alfalfa hay, 13% ground corn and 19% protein-mineral-vitamin blend; TMR nutrient parameters (DM basis) were 17.9% CP, 21% ADF, 30% NDF, 5.7% crude fat, 37% NFC, 18% forage NDF. Milk samples taken at the weeks 0, 4 and 8 were analyzed for percent CLA; blood samples taken at weeks 4 and 8 were analyzed for percent gossypol. Cows received Posilac per label instructions. When covaried for milk production, FuzZ produced more milk than WCS (44.9 vs. 43.0 kg/d, $P = 0.05$); multiparous and primiparous animals had similar numerical response (46.0 vs. 44.0, $P = 0.08$, 41.9 vs. 39.7, $P > 0.20$, respectively). Compared to WCS, FuzZ had higher ($P < 0.10$) milk protein yield (1.32, 1.25 kg/d) and milk lactose yield (2.17, 2.03 kg/d) and tended ($P < 0.20$) to have higher milk protein content (2.96, 2.90%) and lower milk fat content (3.36, 3.62%) and MUN (12.9, 14.0 mg/dl). DMI (25.6, 26.1 kg/d), 3.5% FCM (43.7, 43.9 kg/d), 4.0% SCM (40.5, 40.0 kg/d), milk fat yield (1.50, 1.55 kg/d), milk lactose content (4.84, 4.73%), milk total solids content (12.03, 12.12%), milk solids yield (5.39, 5.20 kg/d) and SCC (345, 230, 1000/ml) were similar ($P > 0.20$) for FuzZ and WCS, respectively. Feed gossypol content was 0.80% (FuzZ) and 0.63% (WCS). Blood gossypol was lower for FuzZ at weeks 4 (1.73, 2.14 ug/ml, $P = 0.02$) and 8 (1.82, 2.40 ug/ml, $P = 0.001$). CLA content in milk fat was similar. FuzZPellet™ pelleted whole cottonseed product provides both production and handling advantages.

Key Words: Whole Cottonseed, Milk Production, Gossypol

M204 Effect of feeding red clover or ryegrass silage to dry dairy cows on milk productivity in the next lactation. J. M. Moorby^{*1}, P. H. Robinson², W. J. Fisher¹, and D. W. R. Davies¹, ¹Institute of Grassland and Environmental Research, Anerstywyth, UK, ²UCCE, Dept. of Animal Science, University of California, Davis.

To investigate effects of feeding a high protein silage to dry cows on their subsequent lactational performance, 48 Holstein-Friesian dairy cows were offered ad libitum access to either red clover silage (RC; 22.4% DM, 18.9% crude protein [CP]) or ryegrass silage (RS; 28.0% DM, 17.2% CP) for the last 4 wk of the dry period (DP). After calving, all animals received the same diet of ad libitum ryegrass silage (29.2% DM, 18.1% CP) with a grain based concentrate (24% CP) at 6 kg/d. BW and BCS were recorded weekly until 2 wk before predicted calving date, after which BW was recorded daily until calving, and BCS and ultrasound scans of the *Longissimus dorsi* were recorded every 3 d until calving. BCS and muscle scans were also recorded weekly during lactation. After calving, milk yields were recorded daily and samples for component assays were collected weekly until wk 10 of lactation. DM intake was similar for the two groups during the DP (13.3 vs. 12.8 kg DM/d for cows offered RC and RS respectively). There was no difference in DM

intake over the first 10 wk of lactation (17.2 vs. 17.0 kg DM/d). Mean BW (659 kg), BCS (2.5; 0 to 5 scale), milk yield (32.3 kg/d) and milk composition over the first 10 wk of lactation were not affected by DP treatment, although milk fat percentage over the first 4 wk of lactation was higher ($P < 0.05$) from cows offered RS during the DP (4.0% vs. 4.3%). Calf birth weights were higher ($P < 0.05$) from cows fed RC during the last 4 wk of gestation (bulls: 43.2 vs. 42.1 kg; heifers: 41.8 vs. 39.5 kg), while mean *L. dorsi* depth tended ($P < 0.1$) to be smaller in RC fed cows vs. those fed the GS diet (39.1 vs. 41.4 mm). Feeding RC during the dry period offered little benefit over RS in terms of subsequent lactational performance, although RC may have induced tissue repartitioning at the end of gestation, leading to higher birth weights in calves and smaller *L. dorsi* depths in the cows.

Key Words: Body Condition Score, Calf Birth Weight, *Longissimus dorsi*

M205 Coffee hulls in diets of dairy cows: Nitrogenous compounds balance. A. Lima de Souza^{*1}, R. Garcia², L. Cabral¹, F. Salgado Bernardino², J. Tilemahos Zervoudakis¹, F. Cipriano Rocha², and R. Ferreira Diniz Valadares², ¹Universidade Federal de Mato Grosso DZER/FAMEV/UFMT, ²Universidade Federal de Viçosa DZO/UFV.

The nitrogenous compounds balance of dairy cows fed with four levels (0.0, 8.75, 17.5 and 26.25% DM) of coffee hulls in substitution of ground corn in their concentrate ration, which corresponding to levels of 0.0, 3.5, 7.0 and 10.5% of the total DM in the diet were evaluated. Twelve Holstein-Zebu dairy cows were used in the experiment and they were assigned to three 4 x 4 Latin square design, squares were design using milk production period. All isoproteic diets, 14% CP, contained 60% of corn silage and 40% of concentrate on dry matter basis. The estimative of the faecal excretion was done by indigestible acid detergent fiber (IADF) use as marker. The daily total nitrogen compounds (TN) and urea excretion on urine was obtained by spot urine samples. The regression analysis not verified effect of the coffee hulls levels on total nitrogen intake (441.3 g/day), N-urine excretion (190.8 g/day) and N-milk (114.7 g/day). However, was verified linear effect ($P < 0.05$) on faecal N excretion and N balance, have been estimated increase of 1.244 and a reduction of 1.793 g/coffee hulls units adicioned, respectively. The high N concentrations present on the fiber fraction of coffee hulls as neutral detergent insoluble nitrogen (NDIN) and acid detergent insoluble nitrogen (ADIN), can has been the major responsible by higher faecal N excretion and for negative N balance on animals feeds with higher levels of coffee hulls.

Key Words: Agroindustrial Residue, Concentrate Ration, Nitrogen Balance

M206 Treated extruded soybean meal as a source of fat and protein for dairy cows. A. L. Ure^{*1}, T. R. Dhiman¹, M. D. Stern², and K. C. Olson¹, ¹Utah State University, Logan, ²University of Minnesota, St. Paul.

Two experiments were conducted to study the influence of lignosulfonate-treated or lignosulfonate plus calcium oxide-treated, extruded, partially expelled soybean meals as undegradable protein and bypass fat sources on lactation performance and ruminal fermentation characteristics of dairy cows. In experiment 1, nine lactating dairy cows were used in a replicated 3 x 3 Latin square design with cows being blocked according to milk yield. Each period was 3 weeks in duration with the first 2 weeks for diet adaptation and the last week for data collection. Cows were fed a total mixed diet containing 440 g/kg forage and 560 g/kg grain with one of three extruded soybean meals fed at 110 g/kg of the dietary dry matter. The three soybean meals were 1) twice-extruded soybean meal (ESM), which was used as the control; 2) lignosulfonate-treated, twice-extruded soybean meal (LSM); and 3) calcium oxide plus lignosulfonate-treated, twice extruded soybean meal (CLSM). In experiment 2, 3 ruminally cannulated cows were used in a 3 x 3 Latin square to study the influence of method of treatment of soybean meal on ruminal fermentation characteristics. Treatments and experimental procedures were the same as described in experiment 1. Feeding treated soybean meal to cows in LSM and CLSM treatments did not improve feed intake, milk yield, fat yield, or milk composition in experiments 1 and 2, except that cows fed the LSM and CLSM treatments produced less milk protein compared with the ESM treatment. The proportion of linoleic acid in milk fat of cows fed ESM, LSM, and

CLSM was 4.66^b, 4.67^b, and 4.89^a % of fat, respectively ($P < 0.01$). Ruminal pH, ammonia concentration, and total volatile fatty acids were not affected by treatment. An increased proportion of linoleic acid in milk fat suggests that there is a potential use of calcium salts of fatty acids in protecting the lipid portion of extruded soybean meal and further research is needed to explore this potential with full-fat extruded soybeans.

Key Words: Treated Soybean Meal, Cow, Milk

M207 Forage quality of legume hays fed to dairy cows in the tropics. T. M. Ruiz* and M. Rosario-López, *University of Puerto Rico, Mayaguez, PR.*

Quality of rhizoma perennial peanut (RPP), alfalfa (AH), and Bermudagrass hay (BGH) was evaluated when fed to lactating cows in the tropics during summer. Nine Holstein cows in mid-lactation were assigned to treatments according to a 3x3 Latin Square Design. The three hays were fed *ad libitum* in individual hay feeders. Concentrate allotment was based on milk production at 1kg/ 2.25 kg of milk produced. Production of milk from cows consuming BGH, AH, and RPP hay was 18.9, 20.5, and 20.0 kg/cow/day, respectively. Differences among treatments were not statistically significant ($P > .05$). Fat and protein content of milk were not different among treatments. Composition of the consumed rations was on average 46% hay DM. Hay consumption tended to be lower when RPP hay was fed, these differences were reflected in a significant difference ($P < .05$) in the DM consumed (16.0, 16.6, and 14.9 kg/cow/DM for BGH, AH, and RPP hays). However, when expressed as a percentage of bodyweight, differences in hay (1.27%) and total DM intake ((2.75%)) were not statistically significant. Cows consuming high levels of concentrate supplementation and having low milk yields, do not increase production when fed hays with high nutritive value and quality potential. Under these conditions the use of legume hays with high quality potential is not recommended.

Key Words: Rhizoma Perennial Peanut, Bermudagrass, Hay

M208 Lactational response of Holstein dairy cows to grinding and heat processing of cottonseed. A. R. Foroughi*, R. Valizadeh, A. A. Naserian, and M. Danesh, *Ferdowsi university of Mashhad.*

The objective of this study was to evaluate the effect of processing (grinding and heating) of whole cottonseed (WCS) on milk composition and production of Holstein lactating cows during early lactation. Multiparous cows ($n=8$) averaging 84.50 ± 10.34 days in milk and 36.10 ± 4.46 milk yield (MY) were used in a 44 Latin square design. Cows were divided into four groups, receiving one of the following treatments: 1) WCS; 2) Ground cottonseed (GCS); 3) GCS heated in 140°C and steeped for 2.5 minute (GHCS1); or 4) GCS heated in 140°C and steeped for 20 minute (GHCS2). Diets were similar CP, NDF and NEL. The percentage of whole or processed was fixed at 14%. Total mixed diets were fed individually free choice twice daily. Each period consisted of 21 days and the last 7 days were used to determine milk composition and production. MY was significantly ($P < 0.01$) affected by the diets and was greatest for HGCS2 (34.13 kg/d) and the lowest for WCS (31.13kg/d). Supplementation with HGCS2 resulted in increased milk fat percentage ($P < 0.05$) (3.68%, 3.33%, 3.59% and 3.98% for 1,2,3 and 4 treatments, respectively) and milk fat yield ($P < 0.01$). Milk fat yield showed the same pattern of response as observed for milk fat percent. Milk protein percent was progressively increased, averaging 3.21%, 3.02%, 3.42% and 3.42% for 1,2,3 and 4 treatments, respectively. This represented a 6.5% increase between WCS and HGCS2. Milk protein yield tended ($P < 0.05$) to be higher for cows fed CHCS1 and GHCS2 than for cows fed WCS and GCS. Results indicate that heat associated with grinding process was sufficient to decrease ruminal degradation of the cottonseed protein.

Key Words: Whole Cottonseed, Grinding and Heat Treatment, Dairy Cow

M209 Factors affecting the concentration of hydrogen sulfide in the rumen gas of dairy cows. R. J. Dewhurst*, L. J. Harris, and R. T. Evans, *Institute of Grassland and Environmental Research, Aberystwyth, UK.*

Our earlier work identified a range of potentially useful diagnostic gases in the rumen head-space. Some of these gases, or their derivatives, are

present in breath and could be monitored using sensors incorporated into feeding or milking equipment. Hydrogen sulfide is present at high concentrations in rumen gas and concentrations change rapidly after a meal. The current study investigated the relationship between the addition of sulfur-containing compounds to the rumen and concentrations of hydrogen sulfide in rumen gas. This work used lactating Holstein-Friesian dairy cows with established rumen cannulae. All cows had *ad libitum* access to ryegrass silage prior to the experiments. Silage was taken away prior to each run and test feeds were given when hydrogen sulfide concentrations had declined close to zero (3.5 h later). The first experiment was a Latin Square with 4 cows, 4 periods and 4 treatments—a control (C; no addition) and three iso-sulfur additions to the rumen: 9.98 g sodium sulfate (SS; in 100 ml water), 8.52 g L-cysteine (cys; in 100 ml water) or 9.32 g L-methionine (met). The second experiment was a two-period cross-over design with 4 cows and 2 feeds: freshly-cut ryegrass or freshly-cut white clover. Cows received 9.5 kg of one of the forages and consumed their allocation within 25 min. Samples of rumen head-space gas were obtained at 30 min intervals for 4 h and hydrogen sulfide concentrations were measured immediately. Hydrogen sulfide concentrations increased rapidly (within 30 min), peaked after 1 h and declined close to zero after 4 h. Hydrogen sulfide concentrations at 1 h after test feeds were given were 9, 133, 466, and 98 ppm for C, SS, cys and met respectively (s.e.d. = 64.9; $P < 0.001$). Contrary to expectations, concentrations of hydrogen sulfide were much lower after cows consumed white clover in comparison with ryegrass (83 vs. 604 ppm at 1 h after feeding; s.e.d. = 102.6; $P < 0.001$). Subsequent investigation suggests that this results from the use of sulfide in detoxifying HCN produced from white clover.

Key Words: Rumen, Hydrogen Sulfide, Clover

M210 Sorting by dairy cows fed a dry diet in a tie-stall or free-stall barn. C. Leonardi* and L. Armentano, *University of Wisconsin, Madison.*

The objectives were to compare sorting in tie- vs. free-stall barns and also to measure its relation with milk composition. Forty multiparous and 20 primiparous lactating Holstein cows were utilized in a Cross-over design, with 21-d periods. At the beginning of the study cows averaged 102 DIM and produced 37.7 kg of milk daily. Cows were divided into two homogeneous groups; one group was housed in a free-stall during period one and tie-stall during period two; and *vice versa* for group two. In the free-stall 10 extra cows were also present. Animals were fed the same diet once daily in the free-stall and twice daily at 1100 and 1500 in the tie-stall to obtain approximately 10% daily refusals. Diet consisted of 10.3% wheat straw, 30.2% alfalfa hay, 20.2% corn silage, and 39.3% grain mix (DM basis). Individual cows sorting was estimated in both barns utilizing naturally occurring alkanes and determined directly in the tie-stall barn. The alkanes technique did not work and free-stall individual sorting values are not available. Therefore, only group average sorting in the free-stall was measured and compared to the group average in the tie-stall. Group average sorting was analyzed including treatment and period in the model. Sequence effect and true error were combined. Group average sorting against the longest particles was 63.3% in the free- vs. 73.2% in the tie-stall ($P = 0.03$). There were no significant differences in sorting between the two facilities of the other particles. There were no significant correlations between individual sorting measured in tie-stall and milk production and milk composition. Individual sorting of the longest particles was negatively correlated ($r = -0.57$, $P < 0.001$), and of finer particles was positively correlated ($r = 0.67$, $P < 0.001$), with the percentage of refusals. Sorting estimates made with individual cows in tie-stall is likely to underestimate average sorting in a free-stall barn. Sorting variability among cows in a free-stall setting is not available, but may also differ from that observed in a tie-stall barn.

Key Words: Sorting, Dairy Cows

M211 Utilization of rejected milk in dairy farms by custodial with rice hulls for animal feeding. M. Crespo*, A. A. Custodio, and A. A. Rodríguez, *University of Puerto Rico, Mayaguez, PR.*

In Puerto Rico, milk that does not meet minimum standards for human consumption is dumped in the waste lagoons of the dairy farms, contributing to pollution and not allowing for its nutrient utilization. Rice hulls, although of very low nutritional value, is abundant and accessible especially in the greater dairy cattle zone of the island. The

purpose of the current study was to examine the maximum amount of milk (M) that can be recycled and fermented with rice hulls (RC) to obtain stable silage for use in animal feeding. The experiment was performed with seven treatments in triplicates: 1) Control (39% water 61% rice hulls w/w), 2) 35M:65RC, 3) 42M:58RC, 4) 45M:55RC, 5) 50M:50RC 6) 60M:40RC and 7) 70M:30RC w/w, ensiled in sealed jars of PVC pipes. For pH and the fermentation products value studies, three samples from each treatment were drawn at 0, 14 and 28d. Data was analyzed as a completely randomized design with a 7 (TRT) × 3 (length of fermentation) factorial arrangement of treatments. Results shows pH level was about 3.8 at 14d and 3.9 at 28d for all treatments with 50M or more. Major fermentation product was lactic acid in all treatment except control, which was butyric acid. Lactic acid concentration was highest ($P < 0.05$) for 50 and 60M treatments reaching a level of about 2% by 14d and remained at that level by 28d. For the 70M it reached a peak of 1.76% at 14d. Butyric, acetic, propionic and isobutyric acids concentrations remained below 0.5% in all treatments. Lactic acid in the control was almost undetectable showing the incapacity of rice hulls to provide enough substrate to promote fermentation. Results indicate that proportions of 50 and 60M ensiled well. Ensiling milk with other more nutritive materials, such as straw or hay, should be even more successful as a method of preserving the nutrients of discarded milk for animal feeding and therefore contributing to reducing soil and water contamination.

Key Words: Rejected Milk, Rice Hulls, Silage

M212 Effect of different whole cottonseed concentrations on some hematologic data in dairy cattle. F. S. Hatipoglu¹, M. S. Gulay¹, F. Karakas Oguz², and N. Oguz², ¹Department of Physiology, Burdur Veterinary Faculty, Akdeniz University, ²Department of Animal Nutrition, Burdur Veterinary Faculty, Akdeniz University.

The effects of different concentrations of whole cottonseed (WCS) in the diet on blood parameters (% hematocrit, hemoglobin, MCHC and osmotic fragility of red blood cells) were examined in lactating cows. Four Holstein cows were assigned to a 4X4 Latin Square design with four stages. All stages had 14 d of adaptation and 7 d of data collection periods. All plasma samples were collected before the morning feeding and milking from vena jugularis. The dietary treatments included 0% (control; C), 12.7 % (W-I), 25 % (W-II) and 37.5 % (W-III) WCS of total diet. Total WCS in the diet was calculated to be 0 (control), 1 (W-I), 2 (W-II), 3 (W-III) kg/d. No significant effects of WCS concentration in diet fed were observed for mean % hematocrit ($C=40.75 \pm 1.55$, $W-I=41.00 \pm 3.19$, $W-II=40.25 \pm 5.03$ and $W-III=43.25 \pm 4.96$), hemoglobin ($C=10.93 \pm 0.72$, $W-I=11.19 \pm 1.01$, $W-II=10.26 \pm 0.56$, and $W-III=10.89 \pm 0.31$ g/L) or MCHC ($C=267 \pm 12$, $W-I=277 \pm 30$, $W-II=270 \pm 40$ and $W-III=263 \pm 35$ g/L). Osmotic fragility of erythrocytes showed no treatment effect. Mean milk yield was increased numerically but not significantly by WCS concentrations in the diet ($C=18.30 \pm 0.77$, $W-I=19.77 \pm 0.73$, $W-II=20.09 \pm 0.81$, and $W-III=20.45 \pm 0.91$ kg/d; $P > 0.1$). Short time feeding of up to 37.5% WCS had no negative effects on the hematology of animals. Further studies may be needed to determine whether high concentrations of WCS can be fed safely for longer time periods.

Key Words: Whole Cotton Seed, Osmotic Fragility, MCHC

M213 Effects of conservation of timothy on nitrogen metabolism in lactating dairy cows. R. Martineau¹, H. Lapiere², D. R. Ouellet², D. Pellerin¹, and R. Berthiaume², ¹Université Laval, Québec, Canada, ²Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville, Québec, Canada.

The effects of three methods of conservation of timothy (*Phleum pratense* L.) on N metabolism were investigated in a replicated 3 × 3 Latin square design with 35-day periods. Treatments were: 1) sun-cured hay (H), 2) formic acid-treated silage (F), and 3) bacterial-inoculated silage (I). Percentages of DM were 88.1, 42.3 and 44.5 (SEM=0.96), and percentages of CP (DM basis) were 10.2, 12.0 and 12.2 (SEM=0.27) for H, F and I, respectively. A similar concentrate (14.4% CP; 69.8% ground corn and 13.6% soybean meal) was offered in all treatments at a forage-to-concentrate ratio of 60:40. Six ruminally- and intestinally-cannulated Holstein cows (DIM=162) were randomly assigned to treatments and fed 12 equal meals daily. Cows were allowed to adjust to their diet for a 2-w period, followed by a 6-d total collection period of

urine and feces. The DMI averaged 16.0 kg/d ($P=0.15$). Nitrogen intake was 15% lower with hay (H) than for silages (F+I), yet neither milk production (20.4 vs. 20.2 kg/d; $P=0.63$) nor milk protein content (3.09 vs. 3.12; $P=0.95$) was different. Nitrogen apparent digestibility was 3.8% lower ($P=0.03$) for H than for F+I. At those levels of N intake, cows fed H were 9.8% more efficient ($P=0.06$) to convert digested N into milk N than cows fed F+I, yet they retained 13.2% less nitrogen ($P=0.04$). The proportion of digested N lost in urine was 6.3% lower ($P=0.04$) with restrictively (F) rather than extensively (I) fermented silage, yet N secreted into milk was not increased.

Item	Treatments			SEM	Contrasts ^a		P
	H	F	I		H vs. F+I	F vs. I	
N intake (g/d)	295	341	351	24.91	<0.01		0.35
% of N intake							
Fecal N	37.8	33.4	34.6	1.84	0.03		0.44
Urine N	33.3	29.5	32.8	2.38	0.28		0.13
Milk N	32.4	27.6	28.4	1.99	0.08		0.74
N retained	-1.7	9.5	4.1	3.48	0.04		0.18
% of N digested							
Urine N	50.4	44.2	50.5	3.07	0.25		0.04
Milk N	52.5	41.7	43.7	4.02	0.06		0.68
N retained	-3.2	14.1	5.8	5.48	0.04		0.19

^aH vs F+I: hay vs. silages;

F vs. I: formic acid-treated vs. bacterial-inoculated silage

Key Words: Nitrogen Balance, Formic Acid-Treatment, Bacterial Inoculation

M214 Fermentation characteristics of ensiling wet corn distillers grains in combination with wet beet pulp. K. F. Kalscheur*, A. D. Garcia, A. R. Hippen, and D. J. Schingoethe, South Dakota State University, Brookings.

The objective of this study was to evaluate the fermentation and preservation characteristics of ensiling WDG with WBP. Combinations of WBP and WDG were ensiled in silo bags as follows: 1) 100% WBP; 2) 66% WBP + 33% WDG; 3) 33% WBP + 66% WDG; and 4) 100% WDG. Samples from each treatment were collected for analyses prior to ensiling. Samples were collected at d 4, 8, 21, and 112 for analysis. The initial pH was the greatest for 100% WBP and decreased ($P < 0.05$) as concentration of WDG increased (4.2, 3.9, 3.6, and 3.3 for 100%, 66%, 33%, and 0% WBP, respectively). Dry matter of the feedstuffs prior to ensiling was 23.1, 26.5, 30.2, and 33.0% for 100%, 66%, 33%, and 0% WBP, respectively. Concentrations of ammonia-nitrogen (0.95, 2.98, 5.83, and 6.75% DM) and crude protein (8.6, 18.4, 25.4, and 30.5% of DM) increased with increasing concentrations of WDG. Lactic acid prior to ensiling was greatest for 100% WDG (6.41% of DM) and decreased as WBP was included in the treatments. Propionic and butyric acids were not present prior to ensiling. Acetic acid prior to ensiling was highest ($P < 0.05$) for 100% WBP (1.06% of DM) and decreased as WDG was included in the treatments. By d 4 the pH of all feeds were below 4.0 and did not change throughout the experiment. Acetic acid increased ($P < 0.05$) over time in all treatments, and was highest for the 100% WBP (5.17% of DM). Ensiling WBP and WDG can be an effective method of preserving both wet co-products. The low initial pH for all treatments and the increased acetic acid over time, suggests preservation is enhanced by combining both feedstuffs. Although both feedstuffs are an excellent energy source for ruminants, they have a different nutrient profile. High concentrations of CP, fat, P, and S present in WDG are matched with low concentrations in WBP. Combining both feedstuffs result in blends that are easier to formulate into dairy cattle rations.

Key Words: Wet Distillers Grains, Wet Beet Pulp, Fermentation

M215 Effect of two forms of lauric acid on ruminal protozoa and fermentation pattern in dairy cows. A. P. Faciola^{1,2}, G. A. Broderick¹, A. N. Hristov³, and M. I. Leão², ¹U. S. Dairy Forage Research Center, Madison, WI, ²Universidade Federal de Viçosa MG, Brazil, ³University of Idaho, Moscow.

Reducing ruminal protozoa may improve N utilization. Medium-chain saturated fatty acids such as lauric acid (C12:0) have been shown to suppress protozoa. Six Holstein cows fitted with ruminal cannulae were

used to test the effectiveness of two different forms of lauric acid (LA) for suppressing protozoal population in the rumen; ruminal parameters and DMI also were measured. Cows were randomly assigned to three treatments: 1) Control, 2) 160g/d of LA, or 3) 160g/d of sodium laurate (NaLA, dissolved in 1,600 ml of water). Both LA and NaLA were given in a single dose into the rumen via cannulae before morning feeding. The TMR contained (DM basis): 15% alfalfa silage, 40% corn silage, 30% rolled high moisture corn, 14% soybean meal, 16.6% CP and 29% NDF. Cows were fed ad libitum, protozoal counts were done daily, pH was measured weekly, and ruminal fluid was collected in the last week and analyzed for metabolites. Data were analyzed using proc mixed in SAS. The results are reported in the table below. Protozoa declined rapidly with dosing of both LA and NaLA, approaching the final populations within 3 days. Ruminal ammonia and total free AA decreased with LA and NaLA in parallel to protozoa, suggesting reduced intraruminal turnover of bacterial protein. The results showed that LA, which is less expensive, was equivalent to NaLA for reducing ruminal protozoa, obviating the need to convert LA to NaLA under practical conditions.

Item	Control	LA	NaLA	7SEM	P>F
DMI, kg/d	25.3 ^a	23.8 ^a	21.7 ^b	0.5	0.07
Ammonia, mM	6.6 ^a	2.6 ^c	4.6 ^b	0.5	<0.01
Total free AA, mM	10.4 ^a	6.6 ^b	3.9 ^c	0.8	<0.01
pH	6.25 ^b	6.38 ^b	6.69 ^a	0.09	0.08
Total VFA, mM	75.6	71.6	63.6	13.7	0.83
Acetate, mM	42.6	38.0	38.6	7.6	0.90
Propionate, mM	18.7	20.0	15.4	5.13	0.82
Butyrate, mM	10.0 ^a	8.0 ^{ab}	5.7 ^b	0.8	0.09
Isobutyrate, mM	0.98	0.91	0.92	0.10	0.89
Isovalerate, mM	1.53	1.92	1.71	0.13	0.18
Valerate, mM	1.76	2.66	1.23	0.37	0.15
Protozoa, x 10 ⁶ cells/ml	5.90 ^a	0.37 ^b	0.51 ^b	0.34	<0.01

Key Words: Lauric Acid, Protozoa, Dairy Cows

M216 Effects of forage source on the response of milk fatty acid composition to soybean and marine algal oil supplementation in ewes. C. K. Reynolds¹, S. C. Loerch¹, G. D. Lowe¹, D. D. Clevenger¹, P. A. Tirabasso¹, V. L. Cannon¹, and J. R. Abri², ¹The Ohio State University, Wooster, ²Martek Biosciences, Boulder, CO.

Milk conjugated linoleic acid (CLA) is increased by a mixture of fish and sunflower oils to a greater extent than feeding the oils individually. Our objective was to determine in ewes (78.4 kg BW) the effects of diet forage source on the response of milk fatty acid (FA) composition to an oil supplement (3% of ration DM) based (2:1 respectively, wt:wt) on soybean oil and marine oil in dry microalgae (DHA Gold, Martek Biosciences) high in C18:2 (n-6) and C22:6 (n-3), respectively. Hampshire X Dorset ewes (48) were assigned to one of 4 treatments and 12 pens in a 2 X 2 factorial completely randomized design blocked on the basis of lambing date and number of lambs suckled. Control rations (60:40 forage:concentrate, DM basis) based on alfalfa pellets (AL) or corn silage (CS) were each fed to 6 pens from lambing. After 3 wk adaptation 3 pens each fed AL or CS were switched to similar rations with added oil (ALO and CSO). Milk yield over 3 h and composition were measured at 42 d postpartum. DMI was lower ($P < 0.02$) for CS vs. AL and for oil, but milk yield was not affected. Milk fat content was increased by oil ($P < 0.1$) and milk protein content was higher for AL vs. CS ($P < 0.04$). Total CLA was increased ($P < 0.01$) for CS vs. AL and by oil, and the response to oil was greater for CS ($P < 0.04$). Similarly, total *trans*-C18:1 and C22:6 (n-3) were higher for CS vs. AL and for oil, with a greater response to oil for CS ($P < 0.06$ and 0.01, respectively). In conclusion, milk fatty acid responses to feeding vegetable and marine oils were affected by forage source. Despite large increases in *trans*-C18:1 concentration, milk fat content was increased by feeding unsaturated oils to ewes.

AL ALO CS CSO SEM

DMI, kg/d	4.2	3.6	3.5	3.3	0.1
Milk yield, kg/d	1.7	2.3	2.2	2.0	0.2
Milk fat, g/kg	79.6	92.6	70.7	83.9	6.6
Milk protein, g/kg	58.8	63.1	51.2	53.8	3.2
Total CLA, g/100 g FA	0.4	0.8	1.0	1.6	0.1
Total <i>trans</i> -C18:1, g/100 g FA	5.6	12.6	7.1	18.3	1.0
C22:6 (n-3), g/100 g FA	0.0	1.4	0.1	1.9	0.1

Key Words: Forage, Fatty Acids, CLA

M217 Use of liquid whey, urea and molasses as additives to ensiled wheat straw. F. T. Sleiman*, N. J. Rebeiz, M. G. Uwayjan, M. T. Farran, R. A. Zurayk, E. K. Barbour, and S. K. Hamadeh, American University of Beirut.

Changes in fermentation pattern, consumption and apparent digestibility of wheat straw (S) ensiled with liquid whey (W), urea (U) and molasses (M) were studied using 12 Awassi ram lambs averaging 6 months in age and 36.7 kg BW. The study consisted of a 3 wk trial and a 1 wk collection period. The experimental treatments were: I) 100% S, II) 41% S + 58% W + 1% U, III) 41% S + 55% W + 1% U + 3% M, and IV) 41% S + 54% W + 1% U + 4% M. In addition to ad libitum feeding of straw treatments, each lamb received 1 kg concentrate (14% CP on DM basis) per day. Variations in silage temperatures, recorded at 3 days interval for 30 days, were not significantly different ($P > 0.05$) among the silage treatments (II, III and IV) and averaged 15.5, 18.0 and 17.2 °C, respectively. PH of treatment III was significantly lower ($P < 0.05$) than those of II and IV over the 4 wk ensiling period and averaged 4.56 Vs 4.87 and 4.98, respectively. All lambs had positive but non significant ($P > 0.05$) weight gains at the end of the trial with the highest body weight change recorded for treatment III as compared to I, II and IV (338.5 Vs 194.5, 230.5 and 316.9 g/d, respectively). Silage DMI of W treatments (II, III, and IV) were not significantly different ($P > 0.05$); but these intakes were significantly higher ($P < 0.05$) than that of treatment I and averaged 686, 736 and 707 Vs 435 g/d, respectively. Apparent digestibility of DM was not significantly different ($P > 0.05$) among all treatments and averaged 69.3%. CP digestibility of treatment II was significantly higher ($p < 0.05$) than other treatments (79.7 Vs 59.0 and 60.3% for treatments I, III and IV, respectively). Digestibility of the fiber fractions of II, III and IV were significantly higher ($P < 0.05$) than treatment I; CF (60.2, 66.1 and 62.2 Vs 48.6%), ADF (61.2, 65.8 and 63.5 Vs 46.0%) and NDF (66.7, 71.2 and 68.2 Vs 60.7%). However, digestibility of CF, ADF and NDF of the W supplemented treatments were not different ($P > 0.05$). Results of this study indicate that additives as used improved feed acceptability, animal response, fermentation characteristics and digestibility of ensiled wheat straw.

Key Words: Liquid Whey, Wheat Straw, Ram Lambs

M218 Undegradable intake protein content and digestibility of brome, birdsfoot trefoil, and heat-treated alfalfa samples. H. L. Haugen, S. K. Ivan*, and T. J. Klopfenstein, University of Nebraska, Lincoln.

Two experiments were conducted using two ruminally and duodenally fistulated steers (658 kg) to determine the digestibility of undegradable intake protein (UIP) of smooth bromegrass (*Bromus inermis*), birdsfoot trefoil (BFT; *Lotus corniculatus*), and heat-treated alfalfa (*Medicago sativa* L.) using the mobile nylon bag method. Undegradable intake protein was determined using neutral detergent insoluble crude protein at a single in situ incubation time point based on 75% of the mean retention time estimated from in vitro dry matter disappearance plus a 10 h passage lag. In the first experiment, UIP (% DM) of brome in June and July was 1.82 and 1.71, respectively ($P = 0.11$). Undegradable intake protein (% DM) of BFT increased from 1.30 in June to 1.94 in July ($P < 0.01$). Total tract indigestible protein (IDP) of brome and BFT increased in July ($P < 0.05$). Digestible UIP decreased in July for brome ($P < 0.01$) and tended to increase for BFT ($P = 0.07$). The disappearance of UIP of BFT increased 0.19 percentage units (DM) in July ($P < 0.01$). In the second experiment, alfalfa from plots fertilized with low (66 kg N ha⁻¹) and high (200 kg N ha⁻¹) amounts were dried to simulate three preservation methods: dehydrated (100°C, 10 h), sun-cured

(50°C, 15 h), or lyophilized (-50°C, 72 h) alfalfa. Undegradable intake protein (% DM) was estimated as in experiment one and was 3.13, 2.10, and 1.84 for dehydrated, sun-cured, and lyophilized alfalfa, respectively. Total tract IDP was increased ($P < 0.05$) for dehydrated alfalfa (1.66 % DM) above sun-cured (1.54 % DM) or lyophilized alfalfa (1.57 % DM). Digestible UIP was greater ($P < 0.01$) for dehydrated (46.4%) than sun-cured (25.6%) or lyophilized alfalfa (14.7%) as a result of greater UIP flow to the lower tract. Heat-treated alfalfa samples increased net UIP absorbance in the lower tract as 1.47, 0.56, and 0.27 more percentage units of UIP (% DM) of dehydrated, sun-cured, and lyophilized alfalfa, respectively, disappeared. Overall, UIP digestibility of these forages was low.

Key Words: Undegradable Intake Protein, Undegradable Intake Protein Digestibility, Forages

M219 Preliminary report on dry matter degradability of Cassia tora. J. A. Vergara-Lopez* and R. E. Maldonado, *Instituto Nacional de Investigaciones Agrícolas (INIA) municipio Cataumbo, estado Sulia, Venezuela.*

To evaluate dry matter degradability of Cassia tora (CT) in a tropical dry forest of Venezuela, two Criollo Limonero steers fitted with permanent rumen cannulae and 506 ± 3.5 kg LW, were used. Animals were housed in a feedlot during 14-d and fed with a mixture of Aleman-grass Maraquita in a 80:20 ratio. Samples of CT and Aleman-grass (AG) were cutted from paddock, dried at 105°C in a forced air oven to assess dry matter and milled to 3 mm. Dry samples were weighed in nylon bags (50 μ m pore size) and incubated on 0, 6, 12, 24, 48 and 72 h and analysed for dry matter in a forced air oven at 105°C. Ruminal degradability data were fitted by the model $d=a+b(1-e^{-ct})$, which were analyzed by ANOVA and least square differences test for means comparison. Initial solubility (a) was higher ($p < 0.001$) in CT than AG (20.83 ± 0.43 and 22.21 ± 0.36 for AG and CT, respectively); while b was higher ($p < 0.001$) in AG than CT (58.35 ± 0.81 and 38.77 ± 0.62 for AG and CT, respectively). Fractional rate of degradation (c) was lower ($p < 0.001$) in AG than CT (0.050 ± 0.002 and 0.120 ± 0.011 for AG and CT, respectively), and a+b was higher ($p < 0.001$) in AG than CT (79.22 ± 1.08 and 60.95 ± 0.69 for AG and CT, respectively). Cassia tora had a lower dry matter rumen degradability than Aleman-grass.

Key Words: Cassia tora, Echinocloa polystachya, Ruminal Degradability

M220 Roundup ready® alfalfa is compositionally equivalent to conventional alfalfa. M. McCann*¹, G. Rogan¹, and S. Fitzpatrick², ¹Monsanto Company, St. Louis, MO, ²Forage Genetics International, West Salem, WI.

Roundup Ready® alfalfa has been genetically modified to contain the *cp4 epsps* gene that confers resistance to Roundup® agricultural herbicides. As part of the food/feed safety evaluation, compositional equivalence studies were performed on forage collected from different cutting samples in replicated field trials over two years. Data were collected for proximates (protein, fat, ash and moisture), acid detergent fiber (ADF), neutral detergent fiber (NDF), lignin, amino acids, and minerals (calcium, copper, iron, magnesium, manganese, phosphorous, potassium, sodium and zinc), as well as carbohydrates by calculation. Roundup Ready® alfalfa was compared to its null-segregant control line to determine any statistical differences at the 5% level of significance ($P < 0.05$). Additionally, commercial alfalfa varieties were included to provide population intervals. Results from the analyses in these studies showed that for the majority of comparisons made (310 out of 385), there were no statistically significant differences. For those few comparisons that showed differences between the test and control samples, it is unlikely they were biologically meaningful, since the differences were not consistently observed across field sites, test values were within the population intervals, or test values were observed to be similar to literature and historical ranges. These data are consistent with the conclusion that Roundup Ready® alfalfa forage is compositionally equivalent to the forage produced from other commercial alfalfa varieties currently on the market.

Key Words: Composition, Alfalfa, Equivalence

M221 Digestibility of Streptomyces solubles and effects of its inclusion in diets of lactating dairy cows. M. R. Murphy, M. A. Shah, W. Hu*, A. C. Norman, and C. J. Laesch, *University of Illinois, Urbana.*

Our objective was to determine the digestibility of *Streptomyces solubles* (a 14% crude protein, 10% fat, and 48% dry matter product of the pharmaceutical industry) and effects of its inclusion in diets of lactating dairy cows. Sixteen Jersey cows averaging 131 days in milk were randomly assigned to 4 4 Latin squares with 21-d periods after blocking by parity and rBST. Treatment diets were 50% concentrate, 35% corn silage, and 15% alfalfa silage (on a dry matter basis) and included 0, 2, 4, or 8% *Streptomyces solubles*. Apparent digestibilities of basal diet and *Streptomyces solubles* dry matter were estimated to be 70(SE = 1) and 104(22)%, respectively; digestibility of dietary dry matter tended ($P < 0.11$) to increase linearly with inclusion of *Streptomyces solubles*. Milk fat percentage and 4% fat-corrected milk production increased ($P < 0.05$) when *Streptomyces solubles* were included in the diet, from 5.04 to 5.23% and 26.9 to 28.1 kg/d. Milk and 4% fat-corrected milk production changed quadratically ($P < 0.05$) with *Streptomyces solubles* inclusion and dry matter intake tended ($P < 0.08$) to as well (24.0, 24.4, and 23.1; 27.8, 29.2, and 27.4; and 21.5, 22.3, and 21.7 kg/d at 2, 4, and 8% *Streptomyces solubles*). Body weight decreased linearly ($P < 0.01$) with inclusion of *Streptomyces solubles* and milk protein percentage tended ($P < 0.06$) to also (479, 473, and 467 kg; and 3.96, 3.96, and 3.87% at 2, 4, and 8% *Streptomyces solubles*). *Streptomyces solubles* are a digestible and palatable product that improved lactation performance, particularly when included at 4% of dietary dry matter.

Key Words: Digestibility, Dairy cows, *Streptomyces Solubles*

M222 Effect of replacing concentrates with wormwood on nitrogen balance and ruminal fermentation characteristics in sheep. Y. D. Ko*¹, J. H. Kim¹, M. D. Lee¹, A. T. Adesogan², and S. C. Kim², ¹Division of Applied Life Science, Gyeongsang National University, Jinju, Korea, ²Department of Animal Sciences, University of Florida, Gainesville.

This study investigated the effect of replacing concentrates with air-dried wormwood (*Artemisia montana* Pampan) on the performance of sheep. Four Corriedale x Polwarth sheep weighing 41.3 kg (± 1.3 kg) were fed a diet of rice straw (80%) and pelleted supplements (20%) at 2% of body weight, for four, consecutive 15 d periods. The supplements were made by substituting the concentrate with no wormwood (0%; CT), or low (3%; LW), medium (5%; MW) or high (10%; HW) levels of wormwood on a DM basis (4 x 4 Latin square design). The concentrate (15.58 % CP, 72.1% TDN) contained corn, ground wheat, wheat bran and rapeseed. In each period, sheep were individually housed in metabolism cages for 10 days of dietary adaptation and 5 days of total collection of feces and urine. Rumen fluid was collected from a stomach tube at 0, 0.5, 1, 2, 4 and 8 hr after the morning feed, on day 5 of the measurement period, and analyzed for volatile fatty acids, ammonia and pH. CP digestibility was greater ($p < 0.05$) in LW, MW and HW (56.6, 55.4 and 55.4%) than CT (52.1%). Digestibility of crude fat was greater ($p < 0.05$) in LW (77.2%) than other treatments (72.1-74.5%). N intake did not differ among treatments, but N retention was greater ($p < 0.05$) in LW, MW and HW (2.2, 2.6 and 2.8 g/d) than CT (0.8 g/d). Microbial nitrogen yield was also greater ($p < 0.05$) in HW (17.3 g N/d) than CT (13.6 g N/d). Ruminal pH, was unaffected by treatment, but from 0.5 to 2 hr after feeding, ruminal ammonia N was greater ($p < 0.05$) in sheep fed wormwood diets (8.2-9.7 mg/100ml) than in those fed CT (6.9-7.2 mg/100ml). Total-VFA concentration at 1 and 2 hr after feeding was greater ($p < 0.05$) in sheep fed LW (9.5 and 10.4 mmol/100ml) or MW (10.6 and 10.2 mmol/100ml) than CT (9.1 and 8.8 mmol/100ml). In conclusion, this study suggests that replacing concentrate with 3-5 % wormwood improved N balance and the efficiency of N retention in the sheep.

Key Words: Wormwood, Digestibility, Ruminal Fermentation

M223 Effects of nonstructural carbohydrate and protein sources on performance, ruminal fermentation, total tract digestibility and feeding behavior in growing calves. A. Rotger, A. Ferret, S. Calsamiglia*, and X. Manteca, *Universitat Autònoma de Barcelona Edifici V, Campus UAB, Bellaterra 08193, Barcelona, Spain.*

Four rumen fistulated Holstein calves (BW 132.3 ± 1.61 kg) fed high concentrate diets (10 to 90, forage to concentrate ratio) were assigned to a 4 x 4 Latin square design to investigate the effects of nonstructural carbohydrate (barley or corn) and protein (soybean meal or sunflower meal) sources on ruminal fermentation and animal performance. The following 2 x 2 factorial arrangement of treatments (13.7% CP, 2.8 Mcal ME/kg DM) was used: 1) Barley-Soybean meal; 2) Barley-Sunflower meal; 3) Corn-Soybean meal and 4) Corn-Sunflower meal. Data were analyzed using the PROC MIXED procedure of SAS, main factors being nonstructural carbohydrate source, protein source and their inter-

action. Calf and period were considered random effects. Intake of DM was higher in the corn vs. barley based diets ($P < 0.05$), without affecting ADG (1.2 ± 0.12 kg/d). Consequently, feed efficiency was higher for the barley based diets. Average ruminal pH, total VFA and NH_3N concentration were not affected by main factors (6.6 ± 0.14 , 116.4 ± 5.27 mM and 5.9 ± 2.17 mg/dL, respectively). Total VFA per kg of DM intake was lower in the corn vs. barley based diets (20.07 vs. 25.42 mM/kg DMI, $P = 0.02$) and no significant effects were observed for the proportions of individual VFA. Nonstructural carbohydrate and protein sources did not affect total tract digestibility of DM and OM, estimated with chromium oxide (64.5 ± 2.67 and 65.1 ± 2.74 %, respectively). Feeding behavior, measured by scan sampling at 5 minute intervals, did not vary significantly among treatments. Calves spent 9.97, 2.11, 25.13 and 62.79% of the time eating, drinking, ruminating and resting, respectively. In conclusion, while nonstructural carbohydrate source affected intake, feed efficiency and total VFA per kg of DM intake, protein source did not affect these measurements.

Rabbit Species

M224 Effects of dietary mannan oligosaccharide in comparison to oxytetracyclin on cecal fermentation and performance of rabbits. A.P. Fonseca¹, L. Falcão¹, P. Spring*², and A. Kocher³, ¹Universidade Técnica de Lisboa Instituto Superior de Agronomia, Lisboa, Portugal, ²Swiss College of Agriculture, Zollikofen, Switzerland, ³Alltech Biotechnology Center, Dunboyne, Co. Meath, Ireland.

Digestive disorders in rabbits are quite frequent. Feed additives, which can lower the risk of digestive disorders and enhance performance are useful tools to the rabbit nutritionist. The aims of the present trials were to compare the effects of mannan oligosaccharide (MOS) and oxytetracycline (OTC) on rabbit performance and intestinal fermentation. Two trials were set up as complete randomized designs with Hybrid Hyla rabbits (31 to 70 days). Rabbits were housed individually in metabolic cages. Grower feed was offered through day 46 and finisher feed from day 47 to the end of the trial. The diets did either contain 2000ppm of MOS (Bio-Mos[®], Alltech Inc.) or OTC (20%) in the grower and 1000ppm of MOS or OTC in the finisher diet, respectively. Trial 1 was performed with 48 rabbits. Performance as well as purine derivatives excreted in the urine and caecotrophes (soft feces) composition was determined.

Trial 2 involved 24 rabbit. Performance, diet digestibility and cecal pH and VFA concentrations were determined. All data were subjected to ANOVA. Average daily gain and FCR did not differ between treatments. ADG was 41.7g and 44.1g for the MOS treatment vs. 42.7g and 43.9g for the OTC treatment in trial 1 and 2, respectively (RSD 4.2 and 2.9). Average feed conversion was 3.05 in trial 1 and 3.50 in trial 2 and was not affected by treatment. Composition of the soft feces did not differ among treatments. Diets did affect purine derivatives excretion. Allantoin and uric acid excretion did not differ between treatments; however, rabbits fed MOS did excrete significantly less hipoxantin and xantin. Diet digestibility in trial 2 was modestly affected by treatment, with a significant improvement in ADL digestibility for MOS compared to OTC. Average cecal pH was 6.2 for both treatments. Total VFA concentrations averaged 36 mmol/l and did not differ between treatments. Under the present trial conditions performance with MOS was similar to performance with OTC. MOS did show a reduction in mortality. Differences in cecal fermentation patterns and diet digestibility were modest between the two additives.

Key Words: Rabbits, Mannan Oligosaccharides, Performance

Production, Management and the Environment: Systems, Economics, and Miscellaneous

M225 Minimum dry period length to maximize performance. M. T. Kuhn*, J. L. Hutchison, and H. D. Norman, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

The objective of this research was to find the minimum dry period length while maintaining performance in the subsequent lactation. The number of days dry, month of calving in the subsequent lactation, linear and quadratic effects of the last somatic cell score in the previous lactation, linear and quadratic effects of previous days open, and linear and quadratic effects of age at subsequent lactation were included in the model to look at the effect of dry period length on actual milk yield in the subsequent lactation, adjusted for producing ability. Data included Holstein cows first calving from 1997 to 1999. There were 64,100 records with a second lactation, 28,376 with a third lactation, and 11,997 with a fourth lactation. Peak yield during the following lactation occurred at a dry period length of 45 to 60 days for parities 2, 3, and 4. A difference in milk production of +33, +50, and -16 kg between 56 to 60 and 61 to 70 days dry was not significant for lactations 2, 3, and 4, respectively. A dry period length over 70 days resulted in a 250, 622, and 727 kg decrease in milk production for lactations 2, 3, and 4, respectively. Although peak yield in subsequent lactation occurred between 45 and 60 days, the rate of increase from zero to 45 days was not linear. Cows that were dry from zero to 35 days following first, second, and third lactations showed an average decrease of 1111, 491, and 1802 kg in second, third, and fourth lactations, respectively. In contrast, cows that were dry from 35 to 45 days had an average loss of only 280, 172, and 182 kg in lactations two, three, and four, respectively. Further research

will determine optimum dry period length for lifetime yield, somatic cell score, female fertility, fat and protein percentages, and productive life.

Key Words: Dry Period Length, Milk Production, Performance

M226 Effect of photoperiod on milk production in lactating dairy cows. M. J. VanBaale*¹, D. V. Armstrong¹, R. M. Mattingly², and J. B. Fiscalini², ¹The University of Arizona, Tucson, ²Fiscalini Dairy Farm, Modesto, CA.

Ninety-eight multiparous and 60 primiparous Holstein animals were utilized in an extended lighting trial to investigate photoperiods impact on milk yield. After parturition all animals were housed in one pen until 20 DIM under normal daylight/nightlight conditions. On d 21, animals were randomly assigned into two treatment groups receiving supplemental light (SL) or normal daylight and darkness (NL). There were four groups of multiparous cows; two were assigned to SL and two to NL. There were only two groups of primiparous animals that were assigned to SL or NL. While in freestalls both multiparous and primiparous cows in the SL groups were exposed to 17h of natural light and SL above 15 foot candle (FC) and 7h of light below 5 FC in the freestall area. The light exposure for the NL groups followed the normal sunrise-sunset pattern common for the north 40th parallel of sunrise 0530 to 0730 and sunset 1700 to 1900, an average of 12h of light and darkness. Light intensity was measured every two wks at 2200 to 2300 at two points in the freestall barn (feed manger and outside lane at animal head level) and in the milking parlor holding pen (front, middle, and back). Diets for both treatments were balanced for 52 kg milk/d. There was no difference ($P = 0.48$) observed between primiparous animals assigned to SL (32.9 kg/d) or NL (32.7 kg/d) treatments. Multiparous cows in

SL groups produced more ($P < 0.05$) milk (49.4 kg/d) than the multiparous groups on the NL treatments (46.5 kg/d). Average pen DMI for multiparous (29.3 vs. 28.4 kg/d) and primiparous (23.4 vs. 22.4 kg/d) animals exposed to SL or NL were not measurably different. Exposure to increased lighting enhanced milk production in multiparous cows but had no effect on primiparous animals. Intakes were similar for the multiparous animal groups exposed to increased day length; however, milk yield was improved. Since no physiological measurements were obtained it is not known what contributed to the increase in milk yield, but increased lighting is an effective management practice that can be used to improve milk production on high producing dairy herds in the San Joaquin Valley of California.

Key Words: Photoperiod, Lactating, Dairy Cows

M227 Reasons and timing of cows leaving dairy herds in Florida and Georgia. B. L. Butler* and A. de Vries, *Department of Animal Sciences, University of Florida, Gainesville.*

Our objectives were to determine the reasons and timing of cows leaving dairy herds in Florida and Georgia. DHIA records for individual cows ($n=61,532$) culled on 257 Florida and Georgia dairy herds between 2000 and 2002 were used in the analyses. Producers using DHIA list a major reason for culling. Reasons for culling include voluntary reasons such as cows sold for dairy purposes (DHI code 2) and culled for low milk production (3). Involuntary reasons for culling include feet and legs (1), reproductive problems (4), injury (5), death (6), mastitis (7), disease (8) and udder problems (9). Frequency of the reasons for culling were calculated for the month of culling, herd size (small: 50 to 199 cows, medium: 200 to 699 and large: > 700) and days in last lactation. Values are expressed as average herd cull rates. Total cull rates in months January through December were respectively 3.27%, 3.13%, 3.50%, 2.56%, 3.06%, 2.73%, 3.00%, 3.20%, 3.13%, 3.40%, 3.30% and 3.82% ($p < .0001$). Frequency of death (6) ranged from a high in August (0.42%) to a low in May (0.27%). Most reproductive culls (4) were in January (0.41%), with the fewest in June (0.26%). Annual herd size culling rates for small, medium and large herds were 34.2%, 30.6% and 32.5% ($p < .0001$). Most feet and leg (1) culls were at large farms (4.04%) with the fewest in small herds (1.75%). By herd size, reproductive culls (4) were SM: 5.98%, MD: 4.43% and LG:3.12%. The median days in milk by culling reasons 1 to 9 were respectively 182, 138, 263, 412, 167, 90, 163, 129 and 186 days. Unlike other culling reasons, which occurred more frequently earlier in lactation (< 210 days), culling for reproductive problems (4) occurred more frequently later in lactation (> 240 days). We concluded that the seasonality in the main reasons for culling were substantial.

Key Words: Culling Reasons, Herd Size, Seasonality

M228 Effect of automatic milking systems on milk yield in Italian conditions. M. Speroni, G. Pirlo*, and S. Lolli, *Animal Production Research Institute via Porcellasco, Cremona, Italy.*

Automatic milking systems (AMS) are expected to increase milk yield because of the higher number of daily milkings in comparison with the conventional milking systems. Many factors can influence the number of milking per day per cow. Two of them are parity and environmental conditions which affect animals activity. Most of the studies on AMS have been carried out in Northern Europe and they do not consider the extreme conditions of the Southern Europe, where the summer is very hot and humid. The aim of this experiment was to compare milk yield of cows reared in identical condition and milked by AMS or by milking parlour (MP) in a typical Italian dairy herd located in the Po Valley. From November 2002 to November 2003, 26 primiparous and 10 pluriparous cows were milked with an AMS (DeLaval VMS[®]), at the same time on the other side of the barn 31 primiparous and 10 pluriparous were milked twice a day in a MP (8+8 herring-bone). A selection gate allowed cows to access to the AMS only if interval from last milking was > 5 h. Cows in the MP had milking intervals of 11 h and 13 h between morning and afternoon and between afternoon and morning respectively. Groups were fed the same TMR. Milk yield was recorded one day a week at each milking; temperature and humidity were recorded hourly and used to calculate temperature and humidity index (THI). Summer 2003 was particularly hot and THI constantly exceeded 72 between June and September. In the AMS, milking frequency (MF) was significantly higher ($P < 0.001$) in primiparous than in pluriparous cows. In winter and autumn, MF was 2.67 ± 0.03 and in spring and summer it

was 2.51 ± 0.05 . Effect of season on MF ($P < 0.005$) was higher in primiparous than in pluriparous. Pluriparous cows of AMS yielded 6.68 ± 0.83 kg/d of milk more ($P < 0.001$) than MP pluriparous cows. There was not difference in milk yield between AMS and MP primiparous cows. The negative effect of hot season ($P < 0.001$) was higher for AMS cows than for MP cows. In conclusion AMS increased milk yield but primiparous cows had some difficulties adapting to AMS. Both primiparous and pluriparous milked with AMS were more sensitive to high THI than cows milked with MP

Key Words: Automatic Milking System, Dairy Cows, Milk Yield

M229 Relationship between international body condition scoring systems. J. R. Roche*¹, P. G. Dillon², C. R. Stockdale³, L. Baumgard⁴, K. Macdonald¹, and M. VanBaale⁴, ¹Dexel, Hamilton, New Zealand, ²Teagasc Moorepark, Fermoy, Co. Cork, Ireland, ³Primary Industries Research Victoria, Kyabram, Victoria, Australia, ⁴The University of Arizona, Tucson.

Managing body reserves is critical for farm management, and requires an accurate assessment of the cow's 'condition'. BW alone is not a good indicator of body reserves, as cows of a specific weight may be tall and thin or short and fat. Therefore measuring BCS and changes in BCS of dairy cattle have become essential tools in both farm management and research. The subjective appraisal of body fat stores has been rationalized into numerical BCS systems, but there are many scales in use. In the United States and Europe, 5-point scales are in operation, while an 8-point scale is utilized in Australia and New Zealand uses a 10-point scale. In New Zealand and Ireland, BCS is assessed by palpating individual body parts, while in Australia and the United States the same body parts are visually evaluated. Even though the anatomical regions considered most important are similar in all systems, to date no attempt has been made to relate and compare these systems, making extrapolation and transfer of research findings difficult between systems, and dependent on simple mathematical conversions. The New Zealand 10-point scale was compared to the scoring systems in the U.S., Ireland and Australia by trained assessors. Cows were assessed visually in the U.S. and Australia, and in Ireland by palpating key areas of the cow's body ($n = 105, 112$ and 120 , respectively). Data were analyzed by regression. Positive linear relationships ($P < 0.001$) were found between the New Zealand 10-point and the U.S. 5-point BCS scale (USA = $1.5 + 0.32NZ$; $r^2 = 0.54$; Residual S.D. = 0.34), the European 5-point scale (IRE = $0.81 + 0.40NZ$; $r^2 = 0.72$; Residual S.D. = 0.16) and the Australian 8-point system of scoring (AUS = $2.2 + 0.54NZ$; $r^2 = 0.61$; Residual S.D. = 0.48). The recorded scores converged as the degree of emaciation increased. Results are useful for extrapolating research findings from different countries.

Key Words: Body Condition Score, Dairy Cows

M230 Evaluation of alternative body measurements for growing heifers. D. M. Lefebvre*, B. Gosselin, and R. Lacroix, *PATLQ - Quebec DHI Ste-Anne-de-Bellevue, Quebec, Canada.*

The objective of this study was to validate the use of the Hipometer[®] and other body measurements to evaluate dairy replacement growth. Measurements were made on 969 heifers (898 Holsteins, 71 Ayrshires) from 27 Quebec dairy herds. Body weight (BW) was measured using a portable electronic scale. Body weight predictions from hip width (HW) were made using a Hipometer. Additional measurements included heart girth (HG) taken with a flexible metal tape, height at the withers (HW) and at the hip (HH) using a measuring stick with a crossbar, and body condition score BCS (1-5 scale). BW predictions from HG (HGW) were also calculated using a polynomial equation in use at PATLQ ($559.18 - 22.841 * HG + 0.365 * HG^2 - 2.725 * 10^{-3} * HG^3 + 1.04 * 10^{-5} * HG^4 - 1.526 * 10^{-8} * HG^5$). Age and breed of the heifer were also recorded. Average age of measured heifers was 11.75 ± 7.15 months (Mean \pm SD), ranging from 0 to 30.5 months and BW was 334 ± 176 kg, ranging from 29 to 769. HW was 120 ± 18 cm (range 69-152 cm) and HH was 125 ± 18 cm (range 75-156 cm). HW was closely associated with BW: $HW = 0.9875 BW + 4.9795$; $r^2 = 0.9675$, SD = 31.7 but yielded greater variation than HG-predicted weight: $HGW = 1.0392 BW - 2.3935$; $r^2 = 0.9834$, SD = 23.7. A new second-degree polynomial equation for predicting BW from HG was developed but only yielded marginal improvement in precision ($BW = 58.5 - 2.09 * HG + 0.024 * HG^2$, $r^2 = 0.9843$, SD = 22.03). HW is the commonly used measurement to evaluate skeletal growth but HH is easier to obtain, is less subject to

be influenced by the posture of the heifer being measured and is used by breed associations to evaluate stature for type classification. HH was closely associated with HW, $HH=7.13 + 0.9795 * HW$, $r^2 = 0.984$, $SD=2.3$ cm. These results suggest that the Hipometer[®] is an acceptable method for evaluating BW but is less precise than HG. HH can be used to evaluate skeletal growth, but adjustments are required for comparisons to references.

Key Words: Dairy Heifer Growth

M231 Effect of bedding materials and modified rubber free-stall bases on stall usage by lactating dairy cows. R. Panivivat^{*1}, E. B. Kegley¹, D. W. Kellogg¹, J. A. Pennington², and Z. B. Johnson¹, ¹Department of Animal Science, University of Arkansas, Fayetteville, ²University of Arkansas Cooperative Extension Service, Little Rock, AR.

Two studies were conducted to observe cow preference for using stalls bedded with different materials. In the first experiment, a 2 x 3 factorial arrangement of treatments, commercially available rubber free-stall bases that filled the entire stall were compared to handmade modified rubber bases that filled only the rear half of the stalls, in conjunction with three types of bedding materials (rice hulls, sand, or a base of sand covered with rice hulls [combination]). Thirty-six stalls were equipped with either the full base or the modified base and stalls were filled with the three types of bedding from August 8 to 29, 2001. Cows were observed beginning 3-h post-milking, four times at 30 min intervals on d 7, 14, 21, and 31. Cows used the stalls equipped with the full bases (56% usage) more than the modified bases (44%; frequency procedure [$P < 0.05$]). Cows preferred the combination (61%) to the sand (52%), or the rice hulls (41%; $P < 0.01$). Using the GENMOD procedure, there was a type of base by material interaction ($P < 0.05$); stalls bedded with the combination were used 4.6 times more likely ($P < 0.01$) with the full base than with the modified base. In the second study, 36 stalls were equipped with the full bases and were bedded with the same three types of material from November 19 to December 19. Cows preferred the sand (72%) to the combination (69%), or the rice hulls (60%; $P < 0.001$). Bacterial counts in the bedding were determined on d 30, 31, and 38. There were material by day interactions ($P < 0.05$) for gram-negative, coliform, and *Streptococci* bacteria counts. Bacterial counts were greatest initially in rice hulls and lowest in sand; by d 38 counts were similar for all materials. Cows preferred stalls equipped with the commercially available free-stall bases that filled the entire stall. Cows also preferred stalls bedded with sand or the combination of materials rather than with rice hulls.

Key Words: Cow Preference, Bedding Material, Free-Stall Base

M232 Use of ambient and physiological markers to predict production changes in dairy cows resulting from acute heat challenge. J. D. Sampson^{*}, D. E. Spiers, J. N. Spain, R. P. Rhoads, and M. Ellersieck, University of Missouri, Columbia.

It is well known that cows reduce production during summer months with either acute or chronic exposure to heat stress (HS). An ambient indicator of heat stress (i.e., temperature-humidity index; THI) is traditionally used to predict milk yield (MY) of heat-stressed cows. More recently, a strain index (PSI) has been developed for humans using physiological markers (i.e., rectal temperature, heart rate) to determine HS impact (Moran et al., Am. J. Physiol. 275: R129-134, 1998). The objective of this study was to measure effects of acute HS on lactating dairy cows to identify ambient and physiological parameters that could be used to develop a similar strain index. Multiparous Holsteins (61±8 d postpartum) were acclimated to thermoneutral (TN) conditions (19°C, 55% RH) for 1 week, followed by TN or HS (29°C, 50% RH) exposure for 24 (n=6), 48 (n=4) or 96 (n=2) hrs. Individual daily milk yield (MY; 0400 and 1600 hr) and feed intake (FI) were recorded. Respiration rate (RR), skin temperature (Tsk) and rectal temperature (Tre) were measured every four hrs. Both MY and FI of HS cows decreased ($P < .05$) within 48 hrs from 34.5 to 28.2 kg and 40.2 to 24.5 kg, respectively. Likewise, Tre increased 0.5°C at 24 hrs and 1.7°C at 96 hrs of HS ($P < .05$). Multivariate linear analyses were performed to determine best predictors of production and thermal status. Only correlation coefficients (r) for HS alone were used for comparisons since these values were higher than for a combination TN and HS values. MY was linearly correlated with FI ($r = 0.79$), followed by Tre and change in Tre ($r = -0.73$). Likewise, best physiological predictors of FI included Tre and

change in Tre ($r = -0.75$). There was a close relationship between RR and Tre using either actual values ($r = 0.89$) or change from baseline ($r = 0.91$). Skin temperature was a reliable predictor of RR ($r=0.91$) and Tre ($r=0.88$). These data suggest that thermal status is a reliable predictor of production and should be used in different combinations when developing a PSI for the dairy cow.

Key Words: Heat Stress, Performance, Index

M233 Investigating effects of heat stress on milk production and composition of Iranian Holstein dairy cattle. A. Naserian^{*}, B. Saremi, and F. Karavan, Animal Science Department, Ferdowsi University of Mashhad.

Dairy farms are developing so fast in recent years at north of Iran. This area has a special climate condition (High temperature and humidity during May-October). It's so important to investigate effects of this climate on the performance of cows. The objective of this study was to investigate the effects of temperature and humidity of the weather via an Index (THI), which it is calculated from the following equation: $[Temperature^{\circ}F - (0.55-0.55 \times Humidity\%) \times (Temperature^{\circ}F-58)]$ on milk production and composition of Iranian Holstein dairy cattle in this area. Treatments consider as T1) THI<52 T2) THI between 52-62 T3) THI between 62-72 T4) THI between 72-82 T5) THI>82. Data were obtained from Gorgan dairy farm (700 heads), which is located at line coast of Caspian Sea at north of Iran (Golestan state). Cows were kept in open shed system and milked three times a day and rations were offered as a TMR. Study was conducted between years 2000-2004 and cows were fed according to NRC 1989 and 2001. Measured data were: 1) Mean daily milk for each cow adjusted to Fat 4% (MDM4), 2) Total milk production (TM), 3) Total milk production adjusted to fat 4% (TM4), 4) Fat% (Fat), 5) Maximum daily temperature (MaxT), 6) Daily humidity (Humid). Data were analyzed using General Linear Model procedures of SAS v6.12 to evaluate differences among experimental groups. The design was completely randomized. Means were compared with Duncan test. Data showed that there is a significant difference between MDM4, TM, TM4 and Fat by year and month of recording; at 2003-2004 and between December-May all of milk production and composition were improved ($p \leq 0.01$), which are because of improvement at management of the herd and lack existence of heat stress between mentioned months, respectively. Results showed that all measured factors were reduced significantly by increase in THI ($P \leq 0.05$) (Table1). The results of this study showed that investment for dairy industry in this area is possibly unaccepted.

Table 1: Effect of heat stress on milk production and composition of Holstein dairy cattle

THI	MDM4 Kg	TM Kg	TM4 Kg	Fat%
<52	17.91 ^a	4803 ^b	4451 ^b	3.53 ^a
52-62	18.10 ^a	5046 ^a	4663 ^a	3.52 ^a
62-72	17.17 ^b	4773 ^b	4376 ^b	3.45 ^b
72-82	15.80 ^c	4546 ^c	4090 ^c	3.33 ^c
>82	13.81 ^d	3961 ^d	3529 ^d	3.28 ^d
SEM	0.044	14.75	12.69	0.004

Different words at columns show significant differences between treatments.

Key Words: Heat Stress, Dairy Cattle, Milk Production

M234 Effects of different bone preparation methods (fresh, dry, and fat-free dry) on bone parameters and the correlations between bone-breaking strength and the other bone parameters. W.K. Kim^{*1}, L.M. Donalson¹, P. Herrera¹, C.L. Woodward¹, L.F. Kubena², D.J. Nisbet², and S.C. Ricke¹, ¹Texas A & M University, Collete Station, ²USDA-ARS, Southern Plains Agricultural Research Center, College Station, TX.

A study was conducted to evaluate effects of different bone preparation methods on bone parameters and the correlations between bone-breaking strength and the other bone parameters. Bone-breaking strength is dramatically altered depending on bone preparation methods whereas the other bone parameters such as ash content and ash concentration are not significantly influenced by bone preparation methods. Thus, the objective of this study was to evaluate the effects of three bone preparations (fresh, dry, and fat-free dry) on bone parameters. A

total of 60 Single Comb White Leghorn hens were used for this study. At the end of the 2nd laying cycle (approximately 120 wk of age), hens were euthanized using carbon dioxide gas, and the right tibia and femur were collected. The bones were divided into three treatment groups: fresh, dry, and fat-free dry. Fresh weight, bone volume, dried weight, ash weight, ash concentration, and bone-breaking strength were evaluated. There were no significant differences in fresh weight, bone volume, dried weight, ash weight, and ash concentration of tibia and femur among the treatments. However, fresh tibia (24.13 kg) had a greater bone-breaking strength compared to the dried (9.90 kg) and fat-free dried bones (7.41 kg) ($P < 0.05$). The bone-breaking strength (20.97 kg) of fresh femur was also significantly higher than the dried (9.22 kg) and fat-free dried femurs (6.94 kg). The bone-breaking strength of the fresh bone was highly correlated with dried weight, ash weight, and ash concentration whereas that of the fat-free dried bone was poorly correlated with the other bone parameters. The results indicate that fresh bone gives better bone-breaking strength correlated to the other bone parameters than dry or fat-free dry preparation.

Key Words: Bone-Breaking Strength, Bone Parameters, Bone Preparation

M235 Interrelationships of traits measured on male Angora goats during a central performance test. F. A. Pfeiffer*, C. J. Lupton, and D. F. Waldron, *Texas Agricultural Experiment Station, College Station, TX, Texas A&M University System, San Angelo.*

A pooled correlation analysis was conducted to estimate the phenotypic relationships between traits measured, calculated, or scored on yearling Angora male goats ($n = 462$) that had participated in a central performance test (1997-2003). These annual tests were initiated in 1967 to evaluate goats from different herds at a central location for growth, mohair production, and fiber characteristics, and to help breeders identify genetically superior animals. Correlation analyses had been reported earlier (1981 to 1984 data) when selection emphasis was primarily on mohair production. With changes in economic emphasis and the size and structure of the Angora goat industry over the past ten years, it is of interest to re-estimate these correlations. Characteristics measured or scored included initial and final body weights (IW and FW), average daily gain (ADG), scrotal circumference, grease fleece weight (GFW), clean fleece weight (CFW), average fiber diameter (AFD) and variability (SDFD), clean yield (CY), med (M), kemp (K), average staple length, face cover score, neck cover score, and fleece character score. Previously reported significant correlations ($r = 0.3$, $P < 0.01$) between FW and the fleece weights were not present ($r < 0.1$, $P > 0.05$) in this analysis. Conversely, significant but antagonistic correlations ($r = -0.15$, $P < 0.01$) between ADG and the fleece weights and CY and AFD ($r = 0.18$, $P < 0.01$) were present in the current analysis but had not been reported previously ($r < 0.05$). The magnitude of the favorable correlation between FW and ADG ($r = 0.47$) and the antagonistic relationships between GFW and CY ($r = -0.23$), GFW and AFD ($r = 0.50$), and CFW and AFD ($r = 0.57$) were similar in both studies. Three previously unreported correlations are noteworthy: AFD and M ($r = 0.40$), M and K ($r = 0.60$), and ADG and SDFD ($r = 0.16$). The newly calculated correlation coefficients are expected to assist breeders to better understand the consequences of selecting for individual traits.

Key Words: Angora Goat, Mohair, Central Performance Test

M236 Factors affecting performance and carcass characteristics of beef cattle: a meta-analysis. M. J. McPhee*, J. W. Oltjen, T. R. Famula, and R. D. Sainz, *Department of Animal Science, University of California, Davis.*

A meta-analysis of the main factors affecting finishing average daily gain (FADG; kg/day), intramuscular fat percentage (IMF), 12/13th rib fat (BF; cm), longissimus muscle area (REA; cm²) and kidney, pelvic and heart fat percentage (KPH) at harvest were assessed. Twenty-six papers from 1990 to 2003 were evaluated where consistent IMF data was a key selection criterion. Twenty experiments from 16 papers were selected and used in the analysis. Over 80 variables were entered into a data base and additional variables were created as the data were coded for analysis. In total 93 variables were available for analysis, e.g. sample sizes (n), pen numbers and s.d. for each carcass characteristic. Three categories were developed to distinguish: (1) end point at harvest (i.e.

age, weight or fat depth); (2) experimental unit (pen or individual animal (ExpUnit); and (3) weight class (WtClass) (e.g. adjusted for carcass weight). The data were analyzed using the mixed model procedure in SAS with n as the weighting variable. The terms in the model were paper, system (feedlot or pasture), implant (Yes or No), breed (8 categories), End Point, ExpUnit, WtClass, Weaning age, Days on feed before harvest (DOF), Final Age and Carcass wt. All terms were fitted as fixed effects except for paper which was fitted as random; weaning age, days on feed, final age and carcass weight were covariates. Non-significant terms were deleted from the model and the three most significant, determined by the F statistic, are reported. Residual variances of papers were 12, 4, 5, 6 and 4 % for FADG, IMF, BF, KPH and REA respectively. The most significant variables in order were: system, DOF and Carcass wt for FADG; System, Carcass wt and End Point for IMF; Carcass wt, Breed and WtClass for BF; Carcass wt, WtClass and End Point for KPH; and Carcass wt, Breed and Weaning age for REA. These analyses will provide valuable inputs to an ongoing program for modeling beef cattle growth and carcass quality.

Key Words: Cattle, Meta-Analysis, Carcass Characteristics

M237 Cow and calf performance in a management system including twinning and early weaning. R. Wasson*¹, J. E. Larson², D. R. Brown¹, A. DiCostanzo², J. D. Arthington³, and G. C. Lamb¹, ¹North Central Research and Outreach Center, University of Minnesota, Grand Rapids, ²Department of Animal Science, University of Minnesota, St. Paul, ³Range Cattle Research and Education Center, University of Florida, Opa.

We evaluated the effects of early weaning calves from cows that had twins on cow and calf performance, compared to a system of early-weaned single calves or normal weaned single calves. During the spring of 2003, cows that gave birth to twins simultaneous to cows calving to a single calf were assigned based on days postpartum and calf sex to one of three management systems: 1) cows with twins were maintained together until both calves were early-weaned from the cow at 81 ± 2.5 d (TWIN; $n = 7$); 2) cows with a single calf were maintained together until the calf was early-weaned at 76 ± 3.4 d (SE; $n = 8$); 3) cows with a single calf were maintained together until the calf was weaned at 202 ± 3.4 d (SL; $n = 8$). At early-weaning calves assigned to the TWIN and SE systems were exposed to a step-up feeding procedure until they consumed an 85% concentrate diet consisting of corn and soybean meal, with access to grass hay. Body weight (BW) and body condition score (BCS) of cows and BW of calves were recorded every 28 d. The MIXED model of SAS was used to analyze all data as repeated measures. At 60 d prior to calving BW and BCS of cows did not differ. At Calving the percentage change in BW and BCS was greater ($P < 0.05$) for SE (0% and 5.2 ± 0.2 for BW change and BCS, respectively) and SL (-3% and $5.6 \pm .2$ for BW change and BCS, respectively) than TWIN (-12% and $4.0 \pm .2$ for BW change and BCS, respectively) cows. At d 44, 72, and 100 BW and BCS was greater ($P < 0.05$) for SE and SL than TWIN cows, whereas at d 128 to 204 BW and BCS for TWIN cows was similar to SE and SL. Average BW of calves at birth was greater ($P < 0.01$) for SE (42.3 ± 8.6 kg) and SL (42.2 ± 8.1 kg) calves than individual TWIN (30.8 ± 6.5 kg) calves. From birth to d 204 ADG was greater ($P < 0.05$) for SE ($0.98 \pm .06$ kg) and SL (1.05 ± 0.06 kg) than individual TWIN (0.83 ± 0.04) calves; however, total weight per cow weaned was greater ($P < 0.05$) for TWIN (406 ± 13 kg) than SL (253 ± 12 kg) and SE (241 ± 12) systems. We conclude that weaning cows by 80 d with twins influenced BW change and BCS in cows. In addition, TWIN cows weaned more total calf-weight per cow than their single counterparts.

Key Words: Beef Cows, Twinning, Early Weaning

M238 Acute phase protein response to weaning and transport in calves produced by matings of Romosinuano, Angus, and Brahman. J. D. Arthington*¹, D. G. Riley², C. C. Chase, Jr.², W. A. Phillips³, and S. W. Coleman², ¹Univ. of Florida, Gainesville, ²USDA, ARS, Brooksville, FL, ³USDA, ARS, El Reno, OK.

Objectives were to assess acute phase protein (APP) response in calves due to weaning and transport, and to evaluate breed influence on any detected response. Straightbred and crossbred calves ($n = 297$) were produced from all possible matings of Romosinuano (R; tropically adapted breed native to Colombia), Angus (A), and Brahman (B) in central Florida. Calves were weaned at approximately 7 mo of age (September, 2002) and provided a commercial preconditioning concentrate and

free-choice grass hay. Approximately 28 d after weaning, steers (n = 143) were transported 2,200 km to central Oklahoma. As an estimate of inflammation, concentrations of ceruloplasmin, fibrinogen, and haptoglobin were measured in blood samples collected at weaning, 24 and 72 h post-weaning, and on the day of shipping, 24 and 72 h after arrival. Fixed effects were breed type (n = 9 levels: straightbreds [RR, AA, BB], and crossbreds [RA, AR, RB, BR, AB, BA] where letters indicate breed of calfs sire then dam, respectively), herd, sex (weaning only), and sampling time. Animal was a random effect. Following weaning, the concentration of each APP increased ($P < 0.01$; 15, 17, and 19% in the interval from weaning to 72 h for ceruloplasmin, fibrinogen, and haptoglobin, respectively). Irrespective of breed of sire, concentration of each APP was lesser ($P < 0.01$) in calves derived from B dams (average APP concentration = 21.7 and 23.2 mg/dL, 102 and 124 mg/dL, and 2.9 and 3.3 mg HbB for ceruloplasmin, fibrinogen, and haptoglobin, respectively). Following transportation, concentrations of ceruloplasmin and fibrinogen decreased ($P < 0.05$; 10 and 17% in the interval from pre-shipment to 72 h after arrival for ceruloplasmin and fibrinogen, respectively). In contrast, average haptoglobin concentration increased 78% for all calves by 24 h following arrival. Increased haptoglobin concentration was most evident as heterotic effects for AR; i.e., crossbred (AR and RA) concentration (2.71 mg HbB) was greater ($P < 0.01$) than straightbred (AA and RR) concentration (1.41 mg HbB). These data suggest that certain breed effects impact the APP response to calf weaning and shipping.

Key Words: Acute Phase Proteins, Romosinuano, Brahman

M239 Effects of fasting and handling stress of market pigs on plasma concentrations of stress-associated enzymes and carcass quality. D. H. Kim*, J. T. Seo, D. M. Ha, and C. Y. Lee, *Regional Animal Industry Research Center, Jinju National University, 150 Chilamdong, Jinju, Korea.*

One hundred and forty-four cross-bred market pigs weighing approximately 110 kg were randomly divided into six groups in a 3 (duration of fasting prior to loading; 0, 12 and 24 h) \times 2 (handling stress; minimal vs stimulated handling stress) factorial arrangement of treatments. The stimulated handling stress group received overall rough handling including electric prod stimulation during loading, transport and lairage at least once at each step. All the animals received 3-h lairage prior to slaughter. Blood and longissimus dorsi muscle (LM) samples were taken at slaughter and after overnight chilling of the carcass, respectively. Mean plasma glucose concentration, as expected, was less in the 12 h- or 24 h-fasting group than in the 0 h-fasting, whereas cortisol concentration was greater ($P < 0.05$) in the 24 h- vs 0 h-fasting group. Plasma concentrations of stress indicators glucose, cortisol, creatine kinase and lactate dehydrogenase were greater in the stimulated vs minimal handling stress group. There were no interactions between the duration of fasting and handling stress in their effects on these blood

variables. The incidence of pale, soft and exudative (PSE) carcass and drip loss of LM were reduced in the 12 h- or 24 h- vs 0 h-fasting group, whereas the 24-h postmortem LM pH and color including the lightness and redness were not affected by the duration of fasting. The incidence of PSE carcass and physico-chemical characteristics of LM, however, were not changed by the stimulated vs minimal handling stress. In conclusion, results suggest that fasting the market pig overnight prior to transport is desirable in terms of reducing the incidence of PSE carcass. Rough handling of market pigs may not affect the carcass quality of the animals when an enough lairage time is provided. However, rough handling inflicts a stimulated stress on the animal, which is manifested by increased blood concentrations of stress indicators, and therefore should be avoided for animal welfare.

Key Words: Pig, Stress, Carcass

M240 Economic evaluation of gestation crates versus loose-housing systems for gestating sows. M. Ellis, M. E. Kocher*, and G. D. Schnitkey, *University of Illinois, Urbana.*

The objective of this study was to model the economics of a change from confinement to loose-housing of gestating sows using an economic engineering approach. Analysis was conducted with the base case of a 2,200 sow breeding to weaning operation with gestating sows housed in two alternative systems (crates or loose-housing/fed from electronic sow feeders). Annual total costs for each system were estimated on the basis of the following assumptions. Building and equipment costs were depreciated over 15 and 10 years, respectively, assuming an interest rate of 7%. Total fixed costs of \$1,184,348 and \$1,236,786 for a crate and loose-housed system, respectively, which consisted of costs of building (\$656,613 and \$623,996, respectively), equipment (\$299,480 and \$375,615, respectively), and ownership (i.e., depreciation, interest, repairs, taxes, and insurance) (\$228,255 and \$237,175, respectively). Operating costs (i.e., labor, genetics, feed, utilities, transportation, and veterinary and medicine) and sow productivity levels were assumed to be the same for both systems. Total cost for the system based on gestation crates was \$1,311/sow/year (at a total floor space allowance of 1.67 m²/sow). The costs of the loose-housed system varied with the floor space allowed per sow. At the same floor space assumed for the conventional crate system (i.e. 1.67 m²/sow), the costs for the two systems were similar (\$1,311 vs. \$1,334/sow/year, respectively.) However, costs per sow increased with increasing floor space in the loose-housed system (e.g. 2.04 m²/sow = \$1,521; 2.42 m²/sow = \$1,701; 2.79 m²/sow = \$1,875). In conclusion, the cost to the industry of a move from gestation crates to loose-housed systems will depend on the floor space necessary for successful operation of the loose-housed system.

Key Words: Sows, Housing, Economics

Horse Species

M241 Handling method influences equine urinary calcium and nitrogen. C. I. O'Connor*, B. D. Nielsen, and M. Mayack, *Michigan State University, East Lansing.*

Four mature geldings were used to study the effects of urine handling prior to analysis on Ca and N values. Urine was collected into a clean bucket and then poured through three layers of cheesecloth to remove any hair or debris. The urine was stirred to suspend any precipitate and 5 ml of urine was pipetted into 7-ml vials and the vials were tightly capped. An additional 500 ml of urine was poured into a total collection device (TCD) for later sampling. Urine from each of the 4 horses was blocked by horse and evaluated with twenty-one treatments. Seven combinations of holding time and temperature were examined (frozen immediately, 6 h at 30 C, 6 h at 10 C, 12 h at 30 C, 12 h at 10 C, TCD for 6 h, TCD for 12 h). There were 3 acidification methods evaluated for each combination (no acid, acid added just before freezing, or acid added after urine was thawed). Sample processing was completed within 45 min of collection. Acid was added at a rate of 20 μ l of 12 M HCl/ml urine. All samples were frozen at -4 C until analyzed. Differences between treatments were determined by orthogonal contrasts using the mixed model procedure in SAS 8.2. Urinary Ca was higher when acid was added compared to when no acid was added (1.52 mg/ml \pm 0.18 vs. 0.59 \pm 0.18) regardless of holding time, temperature, or location ($P < 0.01$). The addition of acid prior to freezing tended to result in

samples having higher Ca than samples in which acid was added after urine was thawed ($P = 0.07$), though no other variables had an effect. Urine N was unaffected by the addition of acid to the sample (1.04% \pm .26 vs. 1.05 \pm .26; $P = 0.22$). There was a trend for urine placed in the TCD for either 6 or 12 h to have lower N than urine not placed in the TCD ($P = 0.06$) and urinary N was higher when acid was added after thawing compared to before freezing (1.05% \pm 0.01 vs. 1.01 \pm 0.01; $P < 0.01$). There was no difference in N based upon holding time ($P = 0.77$). Vials were tightly capped and N was not able to volatilize, which may explain why other differences were not seen. These data suggest that urinary Ca is more sensitive to the addition of acid than urinary N but that urine handling methods do influence results.

Key Words: Horse, Urine Nitrogen, Calcium

M242 The effects of FEB-200 on serum progesterone and cortisol levels of pregnant mares in early gestation grazing on endophyte-infected tall fescue pastures. V. Akay*¹, R. Stepp², and P. Karnezos¹, ¹Alltech, Inc., Nicholasville, KY, ²Southern States Cooperative, Inc., Richmond, VA.

Fifty pregnant mares in early gestation from a commercial horse farm in Lexington, KY were used to evaluate the effects of modified gluco-

mannan ergot alkaloid adsorbent (FEB-200, Alltech, Inc., Nicholasville, KY) on serum progesterone and cortisol levels. Pregnant mares (36.2 d pregnant) were maintained on endophyte-infected fescue pastures. Fifteen of these 50 mares received 909 g/head/d of pelleted horse feed (EI-FESCUE). The remaining thirty-five pregnant mares received 909 g/head/d of pelleted horse feed, which included 20 g of FEB-200 (FEB-200). Mares began receiving their respective pelleted feed on June 2, 2003. Pasture tiller analysis indicated that endophyte infection level was higher than 80% in all endophyte-infected tall fescue pastures. Blood samples were drawn into evacuated tubes without anticoagulant every 21 d from May 29, 2003 through Aug 21, 2003. Samples were allowed to clot at room temperature, centrifuged at 1800 x g for 20 min, transferred into small vials, and then frozen (-20°C) for later analysis. Serum samples were analyzed for progesterone (P4) and cortisol levels by the University of Kentucky. Data were analyzed as completely randomized design using PROC MIXED procedure of SAS. PDIFF test was used to examine differences between means of treatments. Differences were declared significant at $P \leq 0.10$. Serum progesterone levels were higher for FEB-200 compared to EI-FESCUE (10.739 vs. 9.678 ng/dl, respectively). At the onset of the experiment, serum cortisol levels were 7.229 and 6.049 $\mu\text{g/dl}$ for EI-FESCUE and FEB-200, respectively. Change in serum cortisol levels was similar ($P = 0.10$) between EI-FESCUE and FEB-200. Pregnant mares grazing on endophyte-infected tall fescue pastures and supplemented daily with FEB-200 had higher serum progesterone levels compared to pregnant mares grazing on endophyte-infected tall fescue pastures without FEB-200 supplementation.

Key Words: Fescue, Progesterone, FEB-200

M243 The effect of MOS supplementation on immune response of mares and their foals. K. R. Spearman* and E. A. Ott, *University of Florida, Gainesville.*

Previous research in other species suggests that mannan oligosaccharide (MOS) supplementation to the diet has positive effects on immune function, including increased serum and colostrum immunoglobulin levels. The objective of this trial was to identify the effects of MOS supplementation to the diet on colostrum and serum immunoglobulin concentrations in the pregnant mare and serum immunoglobulin concentration in her foal. Twenty-six pregnant Thoroughbred ($n=21$) and Quarter Horse ($n=5$) mares were paired by expected foaling dates and assigned at random to the treatment or control group. Treatment mares received 10g of MOS mixed in 45g of ground corn in the morning ration. Control mares received 55g of ground corn in the morning ration. All mares were fed a concentrate designed to provide NRC recommended or higher nutrient intake when fed with Coastal bermudagrass hay or bahiagrass pasture *ad libitum* in season. Both treatments began 56 days prior to the expected foaling date (day-56) for each mare and continued through 28 days post-parturition (day 28). IgG, IgM, and IgA values were determined on mare serum at days -56, 0, and 28. IgG, IgM, and IgA values were determined on colostrum collected before the foal had nursed. IgG, IgM and IgA values were determined on foal serum collected at 0 hour (before foals had nursed), 6-10 hours post-parturition, and at days 7, 14, 28, 56, and 112 of age. The mares receiving MOS supplementation had higher colostrum IgA ($p=0.008$), IgG ($p=0.033$), and tended to have higher IgM ($p=0.076$) concentrations when controlled for pre-lactation colostrum loss, age, and breed. Pre-lactation adversely affected colostrum IgG ($p=0.006$) and IgA ($p=0.008$) immunoglobulin concentration, but had no effect on IgM concentration. There were no significant differences between treatments for mare or foal IgG, IgM, and IgA serum levels at any collection period. This trial suggests that MOS supplementation to pregnant mares increases colostrum immunoglobulin content.

Key Words: Colostrum, Mannan Oligosaccharide, Immunoglobulin

M244 Influence of extender and processing method on fertility and motility of cold stored stallion semen. C. L. Dekat*, G. W. Webb, and K. E. Harrison, *Southwest Missouri State University, Springfield.*

Breeding with cold stored stallion semen has become commonplace in the horse industry. Addition of antioxidants to combat the deleterious effects of reactive oxygen species have been shown to improve motility and conception rate in cattle and sheep. Therefore, an experiment was designed to determine if pregnancy rates could be increased by supplementing the diluents used to store stallion spermatozoa with a Tyrode's

media containing pyruvate and lactate. Semen was collected from a mature stallion on an every other day basis. At least one aliquot from each ejaculate was diluted in a commercially available 2.4% skim milk-5% glucose extender (SKMG) (Exodus Breeder's Supply, York, PA) at a ratio of 3:1 (extender: semen). Additional aliquots were centrifuged at 400 x g for 10 min to remove the majority of seminal plasma. The sperm pellet was re-suspended with the same extender used in the other treatment supplemented at a ratio of 2:1 with a Tyrodes (Sigma # T2145) media (TLP) which contained 20mM lactate (Sigma #L1375) and 6mM pyruvate (Sigma # P4562). Following processing aliquots were stored for 48 h in a commercially available cooling device (Equine Express®, Exodus Breeder's Supply, York, PA). After storage aliquots were analyzed for spermatozoal motility (CASA system) and used to inseminate mares. Thirteen mares were assigned to extender treatment on an every other mare basis when a follicle of 30 mm was visualized by trans-rectal ultrasonography. At d 14 post ovulation mares were examined for pregnancy, administered prostaglandin, and assigned to the alternate extender treatment for the resulting estrus. No difference ($P > 0.05$) in pregnancy rates between SKMG, TLP, and fresh were realized even though spermatozoa stored in TLP had higher means for total and progressive motilities ($P < 0.05$). Findings of this study indicate that removal of seminal plasma by centrifugation and the addition of a Tyrode's media supplemented with lactate and pyruvate to long term storage media had a significant effect on motility but not conception rates.

Key Words: Stallion, Semen, Pyruvate

M245 Affect of pyruvate and cholesterol on post thaw motility of frozen stallion spermatozoa. K. E. Harrison*, G. W. Webb, and C. L. Dekat, *Southwest Missouri State University, Springfield.*

Inclusion of Tyrode's salt solution, pyruvate and/or cholesterol as components of semen extender has been shown to be beneficial for some stallions. The purpose of this study was to determine if either cholesterol or pyruvate, or the combination of the two, would be beneficial when stallion spermatozoa were frozen with an extender consisting of skim milk glucose supplemented with Tyrode's salt solution. Four ejaculates were collected from each of two stallions. After centrifugation at 400 x g to remove the majority of seminal plasma the sperm pellet was re-suspended in one of six extender treatments. Two treatments were re-suspended with 2.4% skim milk-5% glucose extender supplemented with a Tyrode's solution (Sigma # T2145) that contained 20mM lactate (Sigma # L1375) with (TLP) and without (TL) 6mM pyruvate (Sigma # P4562). The same diluents were used for two additional treatments with a further supplementation of a cholesterol-cyclodextrin complex (TLPC, TLC). The fifth treatment served as a control and was re-suspended in SKMG without Tyrode's solution. The first five treatments all contained egg yolk (4%) and glycerol (3%). The last treatment consisted of a commercially available Lactose-EDTA extender (E-Z Freezin, ARS, Chino, CA). Semen was packaged in 0.5 mL straws and frozen in liquid nitrogen. Following minimum 24 h storage, thawed samples were analyzed by CASA for total and progressive motility of sperm, VAP, VCL, VSL and elongation after 5, 10 and 15 min of warming. After 5 and 10 min of warming, motility ($P < .001$) and progressive motility ($P < .001$) of both aliquots that contained cholesterol (TLC, TLPC) were higher than all treatments. The inclusion of cholesterol as a component of a modified Tyrode's salt media used to supplement SKMG improved the post thaw motility of stallion spermatozoa.

Key Words: Stallion, Pyruvate, Cholesterol

M246 Influence of season and cooling device during commercial shipment of stallion semen. G. W. Webb*¹, M. J. Arns², M. A. Harris², and C. L. Dekat¹, ¹Southwest Missouri State University, Springfield, ²University of Arizona, Tucson.

Producers have several commercially available cooling devices available for use during the transportation of stallion semen. Some concern has been expressed regarding disposable static cooling devices in regards to their ability to maintain satisfactory cooling rates and/or storage temperatures. In the current study, Smart Button temperature loggers (Empire Instrument, Big Bear Lake, CA) were incorporated within diluted semen packaged according to manufacturers instructions for two commercially available transportation devices. One of the devices was a disposable unit and the other a standard rigid/plastic device designed for multiple shipments. A temperature logger was also attached externally

to measure ambient temperatures. Semen was collected from each of two stallions diluted at a ratio of 3:1 (extender: semen) with a commercially available stallion semen extender (Exodus Breeders Supply, York, PA) and packaged into each of the containers. Three sets of containers per season (winter and summer) were commercially shipped from Tucson, AZ to Springfield, MO with overnight delivery. Spermatozoal motilities were evaluated utilizing CASA following shipment. Containers were exposed to ambient temperatures that range from a high of 41°C during the summer to a low of 5.5°C during flight in the winter. Values for progressive motility of spermatozoa following 24 h of storage and shipment were similar ($P > .05$) for both cooling devices. Final storage temperatures following 24 h were similar ($P > .05$) for both devices. These data suggest that during both the winter and summer months in the southwestern United States, disposable cooling devices can be used to ship or cool stallion spermatozoa for 24 h.

Key Words: Stallion, Semen, Shipment

M247 **Massage as a recovery method in exercising horses.** C. A. S. Porr* and K. Bennett-Wimbush, *Ohio State University, Wooster.*

Delayed onset muscular soreness (DOMS) is a painful condition which often occurs after unaccustomed or intense exercise. While no current therapy prevents DOMS, massage is a one that may alleviate pain more quickly, potentially allowing athletes to compete more effectively in subsequent exercise that may occur within a short time period. With regard to horses, the weight and ability of a rider can compromise proper back function, resulting in shortened strides, stiffened posture, and resistance to riders cues. The objective of this research was to evaluate the effects of massage as a recovery aid on subsequent performances of an exercise test in horses. Ten geldings, five Thoroughbreds (TB) and five Quarter Horses (QH), were randomly divided into two groups and subjected to two exercise tests. A test consisted of two exercise bouts with a 30 min recovery between them and a two hr data collection period following the second bout. Recovery between bouts was either control (walking and standing) or 30 min massage. Massage included a combination of Swedish and sports techniques, and was performed by a single certified equine massage practitioner. Horses in Group 1 received a massage recovery during the first test and a control recovery during the second while horses in Group 2 had reversed treatments. All horses received the same recovery after the second bout of exercise, and 10-12 d elapsed between exercise tests. Heart and respiration rates and plasma for lactate were collected before and after each exercise bout and at 5, 10, 20, 30, and 120 min post exercise. Serum for creatine kinase was collected before and after each exercise bout and at 120 min post exercise. Horses showed lower heart rate (46 ± 8 vs 52 ± 7 ; $P < .03$) and respiration rate (57 ± 15 vs 69 ± 13 ; $P < .05$) during the second exercise test, most likely due to lower environmental temperatures (24.9 vs. 20.8). Also, QH had higher serum lactate concentrations than TB ($P < .01$). There were no effects of massage on any parameters measured, though there were expected effects of exercise on each ($P < .0001$).

Key Words: Massage, Exercise, Horses

Physiology and Endocrinology: Female Reproduction

M249 **Residual feed intake (RFI) and serum concentrations of insulin in developing Brangus heifers from sires with differing EPDs for growth and scrotal circumference.** K. L. Shirley*¹, M. G. Thomas¹, D. H. Keisler², D. M. Hallford¹, D. M. Montrose¹, G. A. Silver¹, and M. D. Garcia¹, ¹New Mexico State University, Las Cruces, ²University of Missouri, Columbia.

Objectives were to evaluate growth, feed intake characteristics, and metabolic hormones related to puberty in Brangus heifers from a desert breeding program. Heifers were from sires with EPDs (accuracy) for yearling weight and scrotal circumference of 28.5 (0.55) and 0.2 (0.44) for a large growth-moderate scrotal circumference sire (LG-MSC), 17.2 (0.61) and 1.0 (0.49) for a moderate growth-large scrotal circumference sire (MG-LSC), and 19.5 (0.54) and 0.5 (0.44) for a sire with balanced EPD values. Eight heifers per sire were weaned at 6 mo of age, trained to a Calan gate system for daily feed intake evaluation, and fed a diet of 11.6% CP and 79.4% TDN until 15 mo of age. Heifers were bled twice weekly to determine concentrations of progesterone and metabolic hormones via RIA and BW was measured every two weeks. In 2003,

M248 **Comparisons of behavioral testing on Morgan horses at different training levels.** K. M. Holt and M. C. Nicodemus*, *Mississippi State University, Mississippi State.*

Horses with an early, successful show career are more profitable and while locomotive studies have been able to predict show performance, limited research has been done on behavioral characteristics that demonstrate show aptitude. The objectives were to quantify behavior in 2 training levels of Morgan horses by performing standardized behavioral tests: 1) 2-year olds in the initial stages of show training (Group 1) and 2) Adult horses (7-13 years old) successfully showing at an advanced level (Group 2). Comparisons of tests results should indicate that if Group 1 has similar results as Group 2 then they are more likely to demonstrate the same success in the future training process as Group 2. 6 registered Morgan horses, 3 for each group, were selected according to the following criteria: 1) consistently managed in the same program (W.H. Miner Agricultural Research Institute); 2) similar training and training levels within each group; and 3) were clinically healthy and sound. The following standardized behavioral tests were randomly performed in a consistent manner on the same day and location: 1) Learning retention- time for the horse to select a previously taught symbol; 2) Problem solving- time to find a reward placed under an obstacle; 3) Touch stimulus- amount of pressure on the skin before the horse reacts; 4) Auditory stimulus- time to re-approach a point where a loud noise was sounded; and 5) Visual stimulus- time to re-approach a point where an unfamiliar object was introduced. If the horse did not immediately and correctly perform test 1 or 2, "failing" was assigned. Both groups were similar in their results except for the learning retention test in which the adult horses were disinterested in the test, both the teaching and testing process, while the young horses were curious. While the similarity between group responses may indicate that the young horses, similar to the adult horses, should be successful in their future training process leading to a more promising show career, unforeseen events may hinder or further future performance. Larger sample populations with different backgrounds may result in more variations.

Table 1. Means (SD) of behavioral testing results for the young minimally trained (Group 1) and adult advanced-trained (Group 2) Morgan horses.

	Group 1	Group 2
Learning Retention	100% Pass	100% Fail
Problem Solving	67% Fail	67% Pass
Touch Stimulus (psi)	2.7(.8)	2.7(1.2)
Sound Stimulus (s)	3.7(4.1)	2.5(.5)
Visual Stimulus (s)	5.6(.8)	5.2(.9)

Key Words: Morgan Horses, Behavioral Testing, Training

results of ANOVA among sires were reported for growth traits, level of feed intake, serum concentrations of leptin, and puberty (J. Anim. Sci. 86(Suppl.1):236). These analyses suggested that heifers from the Balanced EPD sire achieved puberty (i.e., progesterone concentrations > 1 ng/ml) 1 mo earlier than heifers from LG-MSC or MG-LSC sires. Heifers from the Balanced EPD sire also consumed less feed from 11 to 13 mo of age, but no differences in serum concentrations of leptin were observed among sires. Further analyses suggest serum concentrations of insulin were lower ($P < 0.05$) in heifers from a sire with balanced EPDs relative to heifers from LG-MSC ($2.8 < 5.1 \pm 0.7$ ng/mL). Since a strong ($R^2 = 0.96$) regression was observed between BW and time, residual feed intake (RFI) was estimated by predicting daily feed intake with metabolic midweight ($BW^{0.75}$) and ADG. In heifers born to the sires with Balanced and LG-MSC EPDs, RFI was less ($P < 0.05$) than in heifers born to the MG-LSC sire ($-0.59 = -0.38 < 0.70 \pm 0.30$ kg/d). Results suggest Brangus heifers from a sire with balanced EPDs for growth and scrotal circumference appear to have concentrations of

insulin and RFI favorable for earlier onset of puberty than heifers from LG-MSC or MG-LSC sires.

Key Words: Heifer, Puberty, Intake

M250 Inhibition of development of bovine embryos by gossypol timing of inhibitory effects and possible involvement of apoptosis. J. Hernández-Cerón¹, F. D. Jousan^{*2}, P. Soto², and P. J. Hansen², ¹Universidad Nacional Autónoma de México, México, ²University of Florida, Gainesville.

Gossypol, a polyphenolic pigment in cottonseed, inhibits development of bovine preimplantation embryos. The embryonic stage most sensitive to gossypol is not known, however, nor the mechanism by which gossypol blocks development. Objectives were to characterize embryonic stages at which gossypol inhibits development and test involvement of apoptosis in actions of gossypol. For Exp. 1, presumptive one-cell embryos were cultured continuously in medium containing 0, 2.5, 5, and 10 µg/ml gossypol. Cleavage rate was not reduced by gossypol but the percent of one-cell embryos that became blastocysts 8 d post-insemination (pi) was reduced (P<0.05) by 10 µg/ml gossypol (14.4, 14.3, 12.2, and 7.6% for 0, 2.5, 5 and 10 µg/ml; 6 replicates with 180-242 oocytes/group, SEM=1.5%). For Exp. 2 (6 replicates, 237-268 oocytes/group), presumptive one-cell embryos were exposed to 0 or 10 µg/ml gossypol for either 24 h or 8 d. The proportion of embryos developing to the blastocyst stage was not reduced by 24-h exposure to gossypol (18.4 vs 17.7% for 0 or 10 µg/ml) but was reduced when gossypol exposure was for 8 d (13.0 vs 3.1%; gossypol x incubation time, P<0.03, SEM=1.5%). For Exp. 3 and 4, gossypol did not affect development to the blastocyst stage when two-cell embryos were collected at 30-31 hpi and cultured with gossypol until 8 dpi (Exp. 3) or for 24 h (Exp. 4). In Exp. 5, embryos > 16 cells were collected at 5 dpi, cultured with 0 or 10 µg/ml gossypol for 24 h, and analyzed by the TUNEL procedure to determine apoptosis (n=6 replicates/99-100 embryos/group). There was no effect of gossypol on cell number (51.0 ± 2.8 vs 51.9 ± 2.6 for control and gossypol, respectively) or the percentage of cells that were apoptotic (8.2 ± 0.7% vs 9.2 ± 0.6%). Results indicate that embryonic development can be disrupted by long-term exposure to 10 µg/ml gossypol and that exposure at the one-cell stage is required for disruption in development. Inhibition of development does not appear to involve induction of apoptosis. (USDA NRICGP 2002-35203-12664).

Key Words: Gossypol, Embryo, Apoptosis

M251 Distinct steroidal regulation of mRNAs for aromatase and gonadotropin receptors in bovine granulosa cells. W. X. Luo* and M. C. Wiltbank, University of Wisconsin-Madison, Madison.

Many genes are regulated through estrogen and androgen receptors; however, regulation of gene expression by these steroids in follicular cells has not been completely defined. Granulosa cells of 5 mm bovine follicles were cultured in Medium 199 with 1% fetal bovine serum. Real-time PCR was used to determine mRNA concentrations. In expt. 1, cells were treated with eight different doses of 17 beta-estradiol (E₂), testosterone (T), or 5 alpha-dihydrotestosterone (DHT) for 5 days. Aromatase mRNA was induced by all doses of E₂, but only by high doses (300, 100, 30, 10ng/ml) of T and DHT. Concentrations of LH receptor mRNA increased only after treatments with high doses of E₂, T, and DHT. FSH receptor mRNA was increased by high doses of T and DHT, but not by any dose of E₂. In expt. 2, cells were treated with 30 ng/ml of E₂, T, or DHT for 1, 3, or 5 days. Aromatase mRNA was increased by E₂ and T at all days, but only after 5 d of DHT treatment. The mRNA for LH receptor was not increased by any steroidal treatment on day1. E₂ and T stimulated LH receptor expression on days 3 and 5. FSH receptor mRNA was induced by T and DHT on all days, but by E₂ only on day 1. In expt. 3, ICI (specific estradiol receptor antagonist) inhibited E₂-induced aromatase and LH receptor mRNA expression. In expt. 4, cells were treated with different combinations of FSH (F) (0.3 ng/ml), E₂ (30 ng/ml), and DHT (30 ng/ml) to investigate synergistic effects. F + E₂ + DHT dramatically synergized to induce aromatase mRNA expression compared with other treatments (F + E₂ + DHT = 2373%; FSH = 166%; E₂ = 519%; DHT = 92%; F + E₂ = 1022%; F + DHT = 254%; E₂ + DHT = 760% of control). Thus, androgen from the thecal cells specifically induces FSH receptor and synergizes with FSH and estradiol to induce aromatase expression in granulosa cells. These inter- and

intra-cellular regulatory mechanisms may be critical for normal follicle growth and dominant follicle selection.

Key Words: Granulosa Cell, mRNA, Steroid

M252 Expression of genes encoding steroidogenic enzymes and *in vitro* steroidogenesis by dominant bovine follicles during the 1st follicular wave. K. E. Valdez*¹, S. P. Cuneo², P. J. Gordon³, and A. M. Turzillo^{4,5}, ¹Physiological Sciences, University of Arizona, Tucson, ²Department of Veterinary Science and Microbiology, University of Arizona, Tucson, ³Dairy Veterinary Services, Chandler, AZ, ⁴Department of Physiology, University of Arizona, Tucson, ⁵Department of Animal Sciences, University of Arizona, Tucson.

The hallmark of follicle health is the capacity to produce estradiol (E₂), which requires supply of androgen from theca interna. During the 1st follicular wave following ovulation, concentrations of E₂ in follicular fluid (FF) of the dominant follicle peak around Day 4 of the wave and then quickly decline. The purpose of this study was to elucidate mechanisms responsible for this abrupt decline in E₂ production. Follicular dynamics were monitored by ultrasonography and dominant follicles were collected from Holstein heifers on Day 4, 6, or 8 of the 1st follicular wave (n=4/Day). Steady-state levels of mRNA encoding 17α-OH in theca interna and aromatase in granulosa cells were determined by ribonuclease protection assay. Theca interna and granulosa cells were cultured for 3 h. Granulosa cells were cultured in the presence or absence of 10⁻⁷ M testosterone as substrate for aromatase. Decreased ability of granulosa cells to produce estradiol on Day 6 preceded a loss in aromatase mRNA on Day 8. However, this decrease was not accompanied by significantly lower amounts of 17α-OH mRNA or decreased androstenedione (andro) production by theca interna. From these results we conclude that the decline in FF E₂ observed on Day 6 of the follicular wave is not due to lack of androgen substrate for aromatization or down-regulated expression of the aromatase gene, but instead may be the direct result of decreased activity of the aromatase enzyme within the granulosa cells. Supported by USDA 35203-9167.

Day of wave	FF E ₂ (ng/ml) ^a	17α-OH mRNA in theca interna ^b	Andro secretion (pg/µg protein) ^a	Aromatase mRNA in granulosa cells ^b	Aromatase secretion (pg/10 ⁵ cells) ^a
4	320 ± 42 ^c	97±37 ^c	0.12 ± 0.02 ^{c,e}	194± 37 ^{c,d}	3.5 ± 0.8 ^{c,e}
6	98 ± 33 ^d	45 ± 25 ^{c,d}	0.26 ± 0.08 ^{d,f}	264± 29 ^c	1.8 ± 0.6 ^{d,f}
8	83 ± 17 ^d	13 ± 4 ^d	0.19 ± 0.03 ^{d,f}	138± 44 ^d	2.2 ± 0.2 ^{d,f}

^a Mean ± SEM. ^b Mean CPM ± SEM.

^{c,d} Values within each column with no common superscripts differ (P< 0.05).

^{e,f} Values within each column with no common superscripts tend to differ (P< 0.08).

Key Words: Bovine, Ovary, Steroidogenesis

M253 Effects of dietary supplemental fat on reproductive performance and body composition in pre-puberal beef heifers. A. R. Dos Santos*¹, S. T. Willard², O. J. Sharpe³, and R. C. Vann¹, ¹Brown Loam Experiment Station, Raymond, MS, ²Mississippi State University, Mississippi State, ³Sharpe Farm, Rolling Fork, MS.

Varying results have been reported on use of fat in animal diets to improve growth and influence body composition. Effects of feeding fat on reproduction may occur through stimulation of ovarian function in association with increased dietary energy. Previous data by our laboratory has shown a relationship between body composition (percent intramuscular fat; %IMF) and reproductive cyclicity in beef heifers. The objective of this study was to evaluate supplemental fat sources, tallow vs Extruded-expelled Soybean meal (ESBM), on reproductive performance and body composition traits in pre-puberal beef heifers. Angus-crossbred heifers (n=63; grazing Ryegrass/bermudagrass) were assigned to two diet groups: corn and commercial protein pellet (G1; n=31) with 3.6% fat (tallow; ME=4.70 Mcal/kg), and corn and ESBM (G2; n=32) with 4.2% fat (ESBM; ME=4.75 Mcal/kg). Diets were formulated to be isonitrogenous (CP 15%) and fed daily at 2.3 kg/hd for 70 d. Ultrasound measurements for body composition traits were taken at d 0, 23, 46, and 70 for ribeye area (REA), back fat (BF), rump fat (RF), gluteus medius depth (GMD) and %IMF. Blood was analyzed for serum progesterone

(P4), total (CH) and HDL-cholesterol. After d 70, estrus was synchronized using CIDRTM and heifers were bred AI. As determined by P4 and estrus detection through d 70, a similar proportion ($P>0.10$) of heifers G2 and G1 were cycling (78% vs 71%) prior to synchrony; however G2 had greater ($P<0.05$) luteal phase serum P4 pre-synchrony than G1. CH increased over the feeding period for both G1 and G2 ($P<0.05$). IMF stress score was negatively correlated to %IMF (-0.24 , $P<0.07$), and GMD was negatively correlated to GMD stress score (-0.34 , $P<0.006$). REA, BF, RF and GMD did not differ ($P>0.10$) relative to the two groups at any time. Pregnancy rate was 54.4% for G2 vs 45.7% for G1 ($P>0.10$). In summary, ESBM as a supplemental fat source vs tallow did not influence body composition or overall reproductive performance post-breeding (AI).

Key Words: Reproduction, Body Composition, Fat Supplement

M254 Lipid transport in the developing bovine follicle: mRNA expression for selective uptake receptors increases and for endocytosis receptors decreases. N. Argov^{*1}, U. Moallem², and D. Sklan¹, ¹Hebrew University, Rehovot, Israel, ²ARO, Bet Dagan, Israel.

Differences in rates of steroid production and secretion will, eventually, determine the developmental rates of ovarian follicles. The major supply of cholesterol, the precursor for steroid and androgen biosynthesis, to ovarian cells is from circulating lipoproteins via membrane receptors from the low density lipoprotein receptor (LDL) superfamily. This occurs by either endocytosis, which has been described for very low density lipoprotein receptors (VLDLr) and for LDL receptors, (LDLr) and by the selective uptake pathway described for the scavenger receptor class B type 1 receptor and the recently described ovarian receptor, lipoprotein receptor related protein 8 (LRP8). The objective of this study was to determine mRNA expression of these four cholesterol receptors in bovine ovarian cells at four different stages of follicular development by semi-quantitative PCR. A different pattern of expression was found for the two types of receptors. In small antral follicles, mRNA expression of the endocytosis receptors was higher than in large antral follicles. Expression of LRP8 mRNA increased linearly with follicular size ($P<0.01$), together with an increase in LDL, VLDL and cholesterol concentrations in the follicular fluid ($P<0.01$). Expression of SRB1 mRNA tended to increase with follicular diameter ($P<0.1$). Since different mRNA expression patterns were found for the two types of receptor, this may imply different regulation of cholesterol supply at different stages of follicular development. Accumulation of LDL and VLDL particles in the follicular fluid of large antral follicles enhances cholesterol availability for the intense steroidogenic activity which is essential at these stages. These processes are vital for normal estrous cycles, follicular function and conception.

Key Words: Bovine, Follicular Development, Cholesterol

M255 The expression and localisation of angiogenic growth factors in the porcine corpus luteum. R. S. Robinson^{*}, A. J. Hammond, G. E. Mann, and M. G. Hunter, *Division of Animal Physiology, University of Nottingham, Sutton Bonington Campus, Loughborough, Leics, UK.*

The growth and development of the corpus luteum (CL) is dependent on angiogenesis. Studies in ruminants have shown that vascular endothelial growth factor (VEGF) and fibroblast growth factor 2 (FGF-2) are likely to be the most important factors controlling angiogenesis in the CL. However, to date, FGF-2 and VEGF protein have not been measured or localised in the porcine CL. The objective of this study was to determine VEGF and FGF-2 concentrations in the porcine CL throughout the oestrous cycle and localise components of the VEGF system. Ovaries were collected from the slaughterhouse and were divided into early, mid and late luteal phase based on their visual appearance ($n=4$ per group). From each animal, 3 CL were homogenised and VEGF and FGF-2 concentrations were determined by ELISA. VEGF and its 2 receptors, VEGFR-1 and VEGFR-2 were localised by immunocytochemistry. Both VEGF and FGF-2 concentrations varied with stage of the oestrous cycle ($P<0.05$). The highest concentrations of VEGF and FGF-2 were observed in the early luteal phase, at the time of the peak of angiogenesis, supporting the hypothesis that FGF-2 and VEGF are key angiogenic factors in the porcine CL. VEGF was localised to both small and large luteal cells at all stages. The strongest VEGFR-1 immunostaining was observed in the endothelial cells of larger capillaries,

but was also present in the cytoplasm of large and small luteal cells at all stages of the cycle. There was moderate staining of VEGFR-2 in the endothelial cells of both larger capillaries and luteal parenchyma throughout the cycle. Since VEGF was localised to the hormone producing cells and the VEGF receptors to endothelial cells, this suggests that VEGF stimulates angiogenesis in a paracrine manner. VEGFR-2 staining was also seen on the membrane and in the cytoplasm of luteal cells, pre-dominantly in the mid and late luteal phase CL, which suggests that VEGF may also regulate luteal cell function. In conclusion, FGF-2 and VEGF system are present in the porcine CL and are likely to play an active role in porcine CL angiogenesis.

Key Words: Pig, Corpus Luteum, Angiogenesis

M256 Factors associated with multiple ovulation in lactating dairy cows. H. Lopez^{*1}, D. C. Caraviello¹, L.D. Satter^{1,2}, and M. C. Wiltbank¹, ¹Dairy Science Department, University of Wisconsin, ²US Dairy Forage Research Center, USDA-ARS, Madison.

The objective of this study was to evaluate factors that might alter natural multiple ovulation rate in lactating dairy cows. Ovaries of cows ($n=267$; > 50 days in milk; DIM) were evaluated weekly by transectal ultrasonography to determine natural (no hormonal treatment) ovulation rate. Cows were fitted with a transmitter to record standing estrous activity, were housed in a freestall barn, and were milked twice daily with milk production recorded. Serum concentrations of progesterone (P4) were recorded weekly starting at wk 1 postpartum and body condition scores (BCS) were determined for all cows monthly. There were 76 (28.5%) anovular and 191 (71.5%) ovular cows by 70 DIM. Lower BCS ($P<0.001$), but not level of milk production ($P>0.10$), was associated with the incidence of anovulation. Multiple ovulation rate for first ovulations in anovular cows that naturally recovered from the condition was 46.3% [19/41]. For second and subsequent ovulations ($n=463$), the level of milk production for 14 d before the d of estrus was associated with increased ovulatory rate ($P<0.001$). To illustrate, incidence of multiple ovulations was 1.6% [2/128], 16.9% [32/189], and 47.9% [70/146] for ovulations when cows were producing <35 , 35 to <45 , and $\#880545$ kg/d, respectively. Duration of estrus (4.3 ± 0.7 vs. 9.9 ± 0.5 h; $P<0.001$) was shorter for multiple (47.2 ± 0.9 kg/d; 92 ± 5 DIM; $n=48$) than single ovulations (38.1 ± 0.5 kg/d; 95 ± 2 DIM; $n=237$). Serum concentrations of estradiol were lower (5.5 ± 0.3 ; $n=15$ vs. 7.8 ± 0.4 pg/ml; $n=71$; $P=0.005$) for estruses with multiple ovulations in spite of larger preovulatory follicle volume (4136 ± 123 vs. 3085 ± 110 mm³; $P<0.001$). Similarly, 7 d later, serum P4 was lower (2.5 ± 0.3 vs. 3.2 ± 0.1 ng/ml; $P=0.04$) in multiple than in single ovulations in spite of larger luteal tissue volume (8291 ± 516 vs. 6405 ± 158 mm³; $P<0.001$). In summary, first ovulation after an anovular condition, and level of milk production for 14 d before the day of estrus, were associated with increased rates of multiple ovulations. Additionally, multiple ovulations were associated with lower E2 at estrus, shorter duration of estrus, and lower P4 7 d after estrus.

Key Words: Dairy Cow, Multiple Ovulation, Milk Production

M257 What regulates ovine placental steroidogenesis? C. Weems^{*}, Y. Weems^{*}, and C. Yin, *University of Hawaii, Honolulu.*

By d 90, the placenta (PL) secretes half of the progesterone (P4) and 85% of the estradiol-17 β in blood and ovariectomy (OVX) does not abort ewes (Y Weems et al., Prostaglandins (PG) 46:277, 1992; 48:139, 1994). Regulation of luteal P4 secretion at d 90 of pregnancy is by PGE₂, not LH, in ewes (Y Weems et al., PG 53:337, 1997) and PGE concentration in uterine and ovarian venous plasma (6 ng/ml) is similar (Y Weems PG 46:277, 1993). Ovine PL PGE secretion is regulated by LH up to d 50 and by pregnancy specific protein B (PSPB) after d 50 of pregnancy (Y Weems et al., PG 71:55, 2003). Indomethacin (INDO), a PG synthesis inhibitor, lowers P4 and PGE in blood by half at d 90 (Bridges et al., PG 58:113; 58:267, 1999). Ovine PL from d 90 OVX pregnant ewes secrete 2-3 fold more estradiol-17 β , PSPB, PGE, and P4, but not PGF₂ α in vitro than intact ewes (Y Weems et al., PG 58:139, 1999). The objective was to determine what regulates ovine PL P4 and estradiol-17 β secretion at d 90 of pregnancy. In Expt. 1, PL slices from d 90 intact or OVX (d 83) pregnant ewes were incubated in vitro in M-199 with vehicle, LH, FSH, PL lactogen, PGE₁, PGE₂, PGD₂, PGI₂, IGF₁, IGF₂, LTC₄, PAF-16, or PAF-18 (1, 10, or 100 ng/ml) for 4 hr. In Expt.

2, PL slices from d 90 intact and OVX (d 83) ewes were incubated in vitro with vehicle, INDO, meclufenamate (MECLO), PGE₁, PGE₂, INDO+PGE₁, MECLO+PGE₁, or MECLO+PGE₂ for 4 hr. Media were analyzed for P4, estradiol-17β, PGE, or PGF₂α by RIA. Hormone data in media were analyzed in Expt. 1 by a 2x3x13 and in Expt. 2 by a 2x9 factorial ANOVA. In Expt. 1, PL P4, PGE, or estradiol-17β secretion was increased (P<0.05) by OVX (two-fold), P4 was not increased (P>0.05) by any treatment other than OVX, and only FSH increased (P<0.05) estradiol-17β secretion (two-fold) in both OVX and intact ewes. In Expt. 2, INDO or MECLO decreased (P<0.05) PL P4 secretion by 88% but did not decrease (P>0.05) PL estradiolβ secretion from intact or OVX ewes and PGE₁ or PGE₂ increased (P<0.05) P4 secretion by more than two-fold only in ewes also treated with INDO or MECLO. It is concluded that FSH probably regulates d 90 ovine PL estradiol-17β secretion, while PGE₁ or PGE₂ regulates d 90 PL P4 secretion.

Key Words: Placenta, Sheep, Steroidogenesis

M258 Evaluation of an SNP in steroidogenic acute regulatory (STAR) protein for reproductive traits in swine. J. G. Kim*, J. L. Vallet, R. K. Christenson, G. A. Rohrer, and D. J. Nonneman, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

STAR transports cholesterol from the outer to the inner mitochondrial membrane, which is the rate limiting step for steroidogenesis. STAR mRNA is expressed in reproductive organs including the testis, ovary, and placenta of the pig. The porcine STAR gene was previously mapped by PCR-RFLP analysis to a region that is within one (chromosome 15; 95% confidence interval: 53-101 cM) of several QTL associated with ovulation rate in swine. However, sequence variation in the porcine STAR gene and its association with swine reproductive traits has not been studied. The objectives of this study were to 1) confirm the location of the STAR gene, 2) identify sequence variation in the coding region, and 3) determine the association of STAR gene single nucleotide polymorphisms (SNPs) with reproductive traits. Primers were designed to amplify and sequence the STAR gene. Two contiguous SNPs (G/C and G/T) in STAR were identified from genomic DNA of Meishan x White composite pigs. The G/T polymorphism changes amino acid 126 from valine to leucine. An assay was designed to genotype the SNP by mass spectrometry. Genotyping of the founders of the resource population indicated that the T allele was found only in Meishans (frequency = 0.81). F2, F8, and F9 gilts with phenotypic data were genotyped for association analysis. Linkage analysis mapped the STAR gene to chromosome 15 position 58.5 cM. Data were analyzed by the General Linear Models procedure of SAS. There was no significant association between the SNP and ovulation rate or age at puberty. Ovulation rate for TT homozygotes (n = 30), GT heterozygotes (n = 90), and GG homozygotes (n = 79) were 12.8 ± 0.53 (least squares mean ± standard error), 13.4 ± 0.32, and 13.4 ± 0.35, respectively. Age at puberty for TT homozygotes (n = 33), GT heterozygotes (n = 93), and GG homozygotes (n = 97) were 169 ± 6, 166 ± 3, and 170 ± 4 days, respectively. Although STAR is located in a QTL region for ovulation rate in the pig, this polymorphism does not appear to affect ovulation rate or age at puberty significantly.

Key Words: Ovulation Rate, Age At Puberty, Gene Mapping

M259 Ontogeny of uterine gene expression in the prepuberal pig. R. L. Richardson*, G. J. Hausman¹, R. Rekaya², L. Lee-Rutherford¹, R. R. Kraeling¹, and C. R. Barb¹, ¹USDA-ARS, Athens, GA, ²University of Georgia, Athens.

The molecular mechanisms that regulate uterine development in the pig are not understood. To better understand physiological pathways controlling uterine function, a custom microarray was developed to profile differential gene expression. Oligonucleotides (70 mer) were produced from sequenced ESTs from the Meat Animal Research Center, ARS, USDA libraries that had at least 90% homology to known genes in The Institute of Genome Research pig gene index. Total uterine RNA was isolated from gilts at 90, 150, and 210 days (d) of age and dye labeled cDNA probes were hybridized to arrays representing about 600 pig genes involved in growth and reproduction. Quantitative analysis using a mixed linear model statistical program identified (P<0.01) 45 genes differentially expressed from 90 to 210 d of age, which included growth factor/hormone receptors, growth and cell cycle regulators, apoptosis and seven transcription factors. The gene bone morphogenetic protein

4, a structural protein and signaling growth factor, was down regulated at 90 d and up-regulated at 150 d. The gene for zona pellucida glycoprotein 3A (sperm receptor) was up-regulated by 150 d and oviductal glycoprotein 1 was up-regulated by 210 d. Both of these genes play a role in the fertilization process and/or early embryonic development. A number of these differentially regulated genes expressed in the pig have not been reported in the human or the pig, including melanocortin 3 receptor and PPAR gamma coactivator 1. These results demonstrate, for the first time, differentially expressed uterine genes in the prepuberal pig. The temporal expression of these key genes that regulate uterine development and function during the prepuberal period will lead to a better understanding of the molecular mechanisms controlling fertilization and early embryonic development.

Key Words: Pig, Uterus, Gene

M260 Observed frequency of monozygotic twinning in lactating Holstein cows. N. Silva Del Rio*, B. W. Kirkpatrick, and P. M. Fricke, *University of Wisconsin - Madison, Madison.*

Bonniers equation has been used to mathematically estimate the frequency of monozygotic twinning in epidemiologic studies of twinning in dairy cattle. Our objective was to empirically determine the frequency of monozygotic twinning in lactating Holstein cows and compare it with that predicted by Bonniers equation. Ear biopsies were collected from 102 sets of Holstein twins from 6 Wisconsin dairies resulting in a sex ratio (Bull:Heifer) distribution of 39% B:H, 27% B:B, 34% H:H. The frequency of monozygotic twinning estimated using Bonniers equation based on the deviation from the expected sex ratio distribution of 50% B:H, 25% B:B, 25% H:H was 34.6% of same-sex twins and 21.0% of all twins. To empirically determine the frequency of monozygotic twinning, DNA was extracted from ear biopsies from same-sex twins (62/102) and was PCR amplified using primers for seven polymorphic microsatellite markers (BM4305, BM6425, BM9289, BMS360, BMS650, BMS823, UW20). Mixed-sex and same-sex twins differing in at least one microsatellite marker genotype were classified as dizygotic twins. Same-sex twins were classified as monozygotic when genotypes were identical for at least 5 microsatellite markers. Of the 62 same-sex twins, 58 were classified as dizygotic and 4 were classified as monozygotic resulting in a monozygotic twinning frequency of 6.5% of same-sex twins and 3.9% of all twins. Complete twinning data was collected throughout a 12-month period on two of the farms representing a total of 1,291 calvings. Both farm (P<0.0001) and season of calving (P<0.005) affected twinning rate. The overall twinning rate was 12.1% for farm 1 and 3.9% for farm 2. Twinning rate was 8.3% from April to June and 9.8% from July to September, both of which were greater (P<0.0005) than the twinning rate of 5.3% from October to December and 2.3% from January to March. We conclude that Bonniers equation overestimated the frequency of monozygotic twinning in this population of Holstein cows. *Supported by USDA NRICGP grant 2002-02033 to PMF*

Key Words: Twinning, Dairy Cattle, Monozygotic

M261 Ontogeny of ovarian gene expression in the prepuberal pig. R. L. Richardson¹, C. R. Barb¹, R. Rekaya², L. Lee-Rutherford¹, R. R. Kraeling¹, and G. J. Hausman*¹, ¹USDA-ARS, Athens, GA, ²University of Georgia, Athens.

The molecular mechanisms that regulate ovarian development in the pig are complex. To better understand physiological pathways controlling functions of the ovary, a custom microarray was developed to profile differential gene expression. Oligonucleotides (70 mer) were produced from sequenced ESTs from the Meat Animal Research Center, ARS, USDA libraries that had at least 90% homology to known genes in The Institute of Genome Research pig gene index. Total ovarian RNA was isolated from gilts at 90, 150 and 210 days (d) of age and used to prepare dye labeled cDNA probes, which were hybridized to arrays representing about 600 pig genes involved in growth and reproduction. Quantitative analysis using a mixed linear model statistical program identified (P<0.01) 41 genes differentially expressed from 90 to 210 d of age, which included genes involved in lipid/steroid metabolism, cell growth and regulation, and extracellular matrix adhesion. The gene, protein kinase-c theta, involved in apoptosis was up-regulated at 210 d. The transcription factor, PRDM2, was up-regulated at 90 and 150 d, but down regulated at 210 d. One unknown gene was down-regulated at 90d and up-regulated by 210 d. A number of these differentially regulated genes which were

expressed in the pig ovary had not been reported in the human, including transcription factors, ATP binding cassette B member 11 and CAAT/enhancer binding protein alpha. These results demonstrate, for the first time, differentially expressed pig genes in the prepuberal pig. The ontogeny of expression of these key genes that regulate ovarian development and function leading to onset of follicular growth during the prepuberal period will lead to a more detailed understanding of the molecular mechanisms controlling follicular development and ovulation.

Key Words: Pig, Ovary, Gene

M262 Ovarian activity of dairy cows fed two amounts of phosphorus. S. K. Tallam*, A. D. Ealy, L. C. Griel, Jr., K. A. Bryan, and Z. Wu, *Pennsylvania State University, University Park.*

Multiparous Holstein cows were used to determine the effect of dietary P on ovarian activity and reproductive performance. Cows were assigned randomly at calving to either a 0.35% (n = 27) or 0.47% (n = 27) P (DM basis) TMR; the high P diet was obtained by adding monosodium phosphate to the low P diet. Ovarian activity was monitored three times weekly by ultrasonography starting 10 DIM until the end of a 60-d voluntary waiting period, after which cows were synchronized and bred using the Ovsynch protocol. During wk 2 of lactation, the number of small (3-5 mm) or large (> 9 mm) follicles and the diameter of the dominant follicle did not differ between groups, but the number of medium (6-9 mm) follicles was lower for the low P diet than for the high P diet. Days to first ovulation and the diameter of the ovulating follicle were not affected by dietary P. During the first wave of follicular growth following the first ovulation, dietary P did not affect the number of follicles of all size categories or the diameter of the CL. The diameter of the dominant follicle was greater for the low P group during this period. Multiple ovulation rate or the proportion of cows that were anovulatory or developed follicular cysts did not differ between groups. The first service conception rate and pregnancy loss during 30-60 d after AI were not influenced by dietary P treatment. Milk production for the first 170 d of lactation, based on DHIA records, was not different between groups. Increasing dietary P from 0.35 to 0.47% did not improve ovarian activity.

Item	0.35% P	0.47% P	SEM	P
Number of small (3-5 mm) follicles ^a	4.6	4.4	0.6	0.81
Number of medium (6-9 mm) follicles ^a	1.2	1.9	0.3	0.06
Number of large (> 9 mm) follicles ^a	1.0	1.0	0.2	0.82
Diameter of dominant follicle ^a , mm	12.5	12.4	1.0	0.95
Days to 1 st ovulation	24.2	28.7	2.4	0.20
Diameter of 1 st ovulating follicle, mm	16.8	15.9	0.8	0.48
Diameter of 1 st wave dominant follicle ^b , mm	16.5	13.9	0.9	0.06
Diameter of 1 st estrous cycle CL, mm	23.6	21.9	1.3	0.33
Multiple ovulation rate ^c , %	38.1	30.0	...	0.58
Proportion of cows with follicular cysts ^c , %	11.5	14.8	...	0.72
Proportion of anovulatory cows ^c , %	19.2	25.9	...	0.56
First service conception rate, %	32.0	44.4	...	0.36
Pregnancy loss (30-60 d) ^d , %	25.0	33.3	...	0.69
Milk yield, first 170 d, kg/d	46.8	45.0	1.4	0.37

^aDuring wk 2 of lactation; ^bFirst estrous cycle;

^cDuring the voluntary waiting period; ^dFirst service only.

Key Words: Phosphorus Requirement, Reproductive Performance, Dairy Cows

M263 Association between plasma urea nitrogen levels and reproductive fluid urea nitrogen and ammonia concentrations in lactating dairy cows. D. S. Hammon*¹, G. R. Holyak², and T. R. Dhiman¹, ¹Utah State University, Logan, ²Oklahoma State University, Stillwater.

Two experiments were conducted to study the relationship between blood plasma urea N (PUN) and ammonia (NH₃), urea N concentrations in fluid of preovulatory follicles and in uterine fluids in lactating dairy cows. In Experiment 1, mean PUN levels were used to distribute cows into two groups: (1) cows with PUN #8805 20 mg/dl (HPUN), and (2) cows with PUN < 20 mg/dl (LPUN). Blood and follicular fluids from preovulatory follicles of 38 early lactation dairy cows were collected on the day of estrus (d 0) 4 hr after feed was offered. Follicular fluid NH₃ was significantly (P < 0.01) higher in HPUN cows (308.05 ± 72.27) compared to LPUN cows (93.88 ± 13.09). Follicular fluid urea N was

significantly (P < 0.001) higher in HPUN cows (22.36 ± 0.44) compared to LPUN cows (17.0 ± 0.34). PUN and follicular fluid urea N were correlated (r = 0.93) within cows. In Exp 2, blood and uterine fluids were collected from 30 cows on d 0 and on d 7. Uterine fluid NH₃ was significantly (P = 0.05) higher in HPUN cows (1562 uM ± 202) than in LPUN cows (1082 uM ± 202) on d 7 d, but not on d 0. Uterine fluid urea N was significantly (P < 0.001) higher in HPUN cows than in LPUN cows on d 0 (26.9 ± 1.3, 20.4 ± 0.7) and d 7 (26.5 ± 1.1, 21.4 ± 1.1). There was a significant (P < 0.01) correlation (r = 0.41) between PUN and uterine fluid urea N within cows. The results of this study indicate that high PUN concentrations were associated with elevated NH₃ and urea N concentrations in the preovulatory follicular fluids on the day of estrus and in the uterine fluid during the luteal phase of the estrous cycle in early lactation dairy cows. Elevated NH₃ or urea N concentrations in the reproductive fluids may contribute to reproductive inefficiency in dairy cows with elevated plasma urea nitrogen.

Key Words: Cattle, Urea, Ammonia

M264 Gonadotropin secretion and ovarian activity in non-pregnant mares treated continuously with GnRH during the anovulatory season. S. Morton*^{1,2}, D. Zieba^{1,2}, and G. L. Williams^{1,2}, ¹Texas A&M University Agricultural Research Station, Beeville, TX, ²Texas A&M University, College Station.

Objectives were to determine if low-dose, continuous infusion of GnRH from Fall to Spring would prevent seasonal anovulation in mares. Twenty Quarter Horse mares, ages 18 mo to 24 yrs, were stratified by age and body condition score and assigned randomly to either a saline Control (n = 9) or GnRH (n = 11) treatment group. Treatments were instituted between September 23 and October 9. Gonadotropin-releasing hormone was delivered in 0.9% physiological saline via Alzet osmotic minipumps (Model 2004) placed s.c. at the base of the neck, with Silastic sham pumps placed in control mares. Pumps were inserted on day 3 following ovulation or during the follicular phase if ovulation did not occur by October 9. Delivery rate of GnRH was 2.5 µg/h (60 µg/d) for the first 60 d, followed by 5.0 µg/h (120 µg/d) thereafter, with all pumps replaced every 30 d. By December 1, all mares had become anovulatory and remained anovulatory until February. Mean serum concentrations of LH were not affected by treatment in anovulatory mares. In contrast, control mares that exhibited ovulatory cycles after study onset had higher (P < 0.05) mean concentrations of LH during all phases of the estrous cycle except diestrus. Mean serum concentrations of FSH were not affected by treatment, but were lower (P < 0.05) from November through January relative to all other months in anovulatory mares. Interovulatory intervals in mares that cycled temporarily did not differ between groups. Ovulatory control mares had slightly larger (P < 0.10) follicles overall than GnRH-treated mares; however, ovulatory follicle diameters for control and GnRH-treated mares did not differ. Ovulatory control mares had higher (P < 0.10) mean concentrations of progesterone during metestrus and late diestrus. In a subgroup of control (n = 5) and GnRH-treated (n = 5) mares, total releasable pools of LH in response to 1 mg GnRH did not differ between groups. Ovulation resumed in 3 control and 3 GnRH-treated mares by March 30. Results indicate that continuous infusion of native GnRH at the doses employed in this study is not sufficient to maintain ovulatory cycles during the anovulatory season.

Key Words: GnRH, Seasonal Anovulation, Equine

M265 Effect of genetic strain, feed allowance, and parity on interval to first ovulation and the first estrous cycle in pasture-managed dairy cows. J. P. Meyer*¹, G. A. Verkerk², P. J. Gore², K. A. Macdonald², C. W. Holmes³, and M. C. Lucy¹, ¹University of Missouri, Columbia, ²Dexel Ltd., Hamilton, New Zealand, ³Massey University, Palmerston North, New Zealand.

Cows with North American (NA) pedigrees in traditional New Zealand (NZ) dairy herds may have poor reproductive performance. The objective was to measure postpartum anovulatory interval (PPAI) and the length of the first postpartum estrous cycle in strains of NA and NZ cows managed in a NZ pasture system. The Overseas90 strain (OS90; n=76) were modern NA cows [high breeding worth (BW) with predominately NA pedigree]; the NZ90 strain (n=86) were modern NZ cows (high BW with predominately NZ pedigree); and the NZ70 strain (n=45) were low BW cows with NZ pedigree. Cows (first, second, or third parity) were

allocated to different pasture-based feeding levels (tons DM per cow annually). Milk was sampled twice weekly and analyzed for progesterone (P4) to determine PPAI (interval to first milk P4 > 2 ng/ml) and the interval between first and second ovulations (cycle one). There was an effect of parity (P<.001), strain (P<.02) and a feed by strain interaction (P<.01) for PPAI. First parity cows had a longer PPAI (40±3 d) compared with second (28±3 d) or third (28±1 d) parity cows. The NZ90 strain had a longer PPAI (35±2 d) compared with either OS90 (27±2 d) or NZ70 (30±3 d). Increasing feed allowance did not decrease PPAI for OS90 or NZ70 cows but led to a shorter PPAI for NZ90 cows (44, 40, 27, and 30±4 d for 5.0, 5.5, 6.0, and 6.5, ton DM/cow, respectively). Cycle one was longer (P<.001) for OS90 (18±1 d) compared with NZ90 (13±1 d) or NZ70 (13±1 d) cows. Both parity and strain affect PPAI in dairy cattle. First parity cows had longer PPAI. Selection for production in NZ (NZ90 vs. NZ70) has led to longer PPAI that can be shortened by increasing feed allowance. OS90 cows have BW similar to NZ90 but shorter PPAI and a longer first cycle. Independent physiological mechanism may control PPAI and the first luteal phase in dairy cattle selected for production in NA and NZ.

Key Words: Postpartum, Dairy, Ovulation

M266 Effect of ovulation rate on development of the ovine corpus luteum. S. E. Echternkamp*, R. A. Cushman, and R. K. Christenson, *USDA, ARS US Meat Animal Research Center, Clay Center, NE.*

Relationships among ovulation rate (OR), corpus luteum (CL) weight (wt), and numbers of small (< 3mm dia.) and medium (3-6 mm) antral follicles were evaluated for Rambouillet (Ram), 1/2 Romanov x 1/2 Dorset (RxD), Romanov (Rom), and Synthetic III (1/2 Columbia x 1/4 Suffolk x 1/4 Hampshire; SIII) ewes. Ovaries were collected at slaughter on d 14 to 17 of pregnancy, and numbers of CL and of visible follicles were recorded. Ovaries and excised CL were weighed individually. None of the variables differed (P > 0.1; NS) between the left and right ovaries and data were combined. Means (± sem) for OR, ovarian wt (less CL), total CL wt, mean CL wt and number of small and medium follicles are reported in Table 1 for the four genetic groups. OR ranged from 2 to 10. Rom ewes had the largest (P < 0.01) OR but the lightest (P < 0.01) individual CL; RxD ewes were intermediate for OR and CL wt relative (P < 0.01) to Rom or to Ram and SIII. Thus, OR and individual CL wt correlated negatively (r = -0.72; P < 0.01). However, total CL wt and number of antral follicles did not differ (P > 0.1) among the genetic groups. SIII ewes had heavier (P < 0.01) ovaries than Rom or RxD. Variables did not differ (P > 0.1) between Ram and SIII. The negative relationship between OR and individual CL weight implies that either 1) the number of follicular cells and/or their luteinization is compromised in prolific ewes or 2) the progesterone threshold level for negative feedback on LH secretion is similar among individual ewes regardless of prolificacy; thus, development of individual CL is limited by lower LH stimulation in ewes with increased OR. Table 1. Genetic effects on OR, ovarian wt, total and individual CL wt, and follicle number

Breed	n	(OR) (No. CL)	Ovarian wt (g)	Total		Small follicles (n)	Medium follicles (n)
				CL wt (g)	Individual CL wt (g)		
Ram	7	2.3±0.4	4.03±0.33	1.83±0.14	0.80±0.05	42.8±6.0	7.0±1.4
RXD	17	3.2±0.3	3.66±0.22	1.59±0.11	0.53±0.03	43.6±3.8	7.2±0.9
Rom	26	4.8±0.3	3.46±0.17	1.60±0.09	0.35±0.02	39.3±3.1	7.5±0.7
SIII	17	2.4±0.3	4.91±0.22	1.73±0.11	0.71±0.03	37.4±3.8	9.2±0.9
P <		0.01	0.01	NS	0.01	NS	NS

Key Words: Ovulation Rate, Corpus Luteum, Sheep

M267 A comparison of the anti-luteolytic activities of recombinant ovine IFN-tau and alpha in sheep. M. P. Green*¹, L. D. Spate¹, J. A. Bixby¹, A. D. Ealy², and R. M. Roberts¹, ¹Dept. of Animal Science, University of Missouri, Columbia, ²Dept. of Dairy & Animal Science, Pennsylvania State University, University Park.

Interferon-tau (IFN-τ) is well established as the maternal recognition signal produced by ruminant conceptuses at the peri-implantation period. The question as to whether IFN-τ is superior as an anti-luteolytic agent to closely related Type I IFNs, such as IFN-α, however, remains unanswered. Previous studies have employed both intramuscular and

intrauterine administration of recombinant IFN-τ or IFN-α and demonstrated that both proteins can extend estrous cycle length in cattle and sheep, but a concurrent comparison of these IFNs has not been undertaken. Thus the aim of this study was to determine whether equivalent antiviral units of ovIFN-τ and ovIFN-α are equipotent in extending estrous cycle length. Recombinant ovine IFNs (ovIFN-τ4 and ovIFN-α1) were expressed in yeast (*Pichia pastoris*) and purified from the culture media. The anti-viral activity of the IFNs was determined on MDBK and ovine uterine epithelial cells by a cytopathic protection assay. Indwelling uterine catheters were fitted into crossbred ewes (n=16) and on d3 post-estrus (d0=estrus). Between d10 to 18 post-estrus, ewes received twice daily infusions of 0.7x10⁷U of either IFN-τ or -α in PBS (n=6 ewes/treatment), adjusted for protein concentration by addition of serum albumin. Control ewes (n=4) received an equivalent amount of serum albumin. Daily blood samples were collected and ewes were monitored twice daily for estrus. Mean estrous cycle lengths were 16.3±0.9, 21.7±4.0 and 33.3±13.9 days for control, IFN-α and IFN-τ treated ewes respectively. Recombinant IFN-τ (p=0.01) and to a lesser extent IFN-α (p=0.04) increased cycle length. Number of CL, d10 temperature and progesterone concentrations throughout the cycle were not significantly (p>0.1) different between the three groups. These data demonstrate ovIFN-α to be an anti-luteolytic agent, but not as potent of one as ovIFN-τ. Supported by NIH Grant HD21896.

Key Words: Interferon, Infusion, Ovine

M268 Effects of monensin supplementation peripartum in metabolic and reproductive parameters in anestrus postpartum Nellore cows. M. C. Matos*¹, D. F. Biluca², J. L. M. Vasconcelos², and F. S. Wechsler², ¹FCAV-UNESP Jaboticabal, SP Brazil, ²FMVZ-UNESP Botucatu, SP, Brazil.

The aim of this study was to evaluate the effects of monensin supplementation peripartum on plasma concentrations of insulin-like growth factor I (IGF-I), nonesterified fatty acids (NEFA), follicular diameter and response to GnRH in anestrus postpartum Nellore cows. Primiparous (n=123) and multiparous (n=179) cows were allocated randomly to 2 groups: G1 = 100g/d of a mineral supplement and G2 = 350g/d of a mineral supplement mixed with citrus pulp and monensin (150mg/d), from 30d prepartum to 90d postpartum. Blood samples, follicular diameter, and body condition score (BCS, scale of 1-5 adapted for 0.25 points) were determined at 54.3±23.08d postpartum, the d of GnRH injection (Cystorelin[®], 50µg, i.m). IGF-I and NEFA were analyzed in a sub-group of animals (n=120) by RIA and enzymatic methods, respectively. Follicular diameter and ovulation to GnRH injection were evaluated by ultrasound. Data were analyzed using a general linear models procedure. Cows supplemented with monensin had greater concentrations of IGF-I (112.0±6.91 vs 65.4±6.89ng/mL, P<0.01) and lower of NEFA (956.8±51.52 vs 1131.2±54.12µmol/L, P<0.05) in relation to the controls. Monensin ingestion increased (P<0.05) the average diameter of the largest follicle in the animals that did (10.0±0.18mm) or did not (9.5±0.17mm) receive monensin. Despite evidence of better metabolic status and larger follicular diameters, monensin did not increase the frequency of ovulation to GnRH (67.5±0.09 vs 63.7±0.09%) nor BCS (3.0±0.02 vs 3.1±0.02). Monensin influenced positively follicular diameter, probably due to effects on energy metabolism, which may have increased LH pulsatility and delayed the turnover of the dominant follicle. These data suggest that monensin ingestion can be a good strategy to improve energy status of peripartum cows and follicular development. This also could improve the responses to synchronization protocols and/or induce cyclicity in anestrus postpartum Nellore cows.

Key Words: Nellore Cows, Anestrus, Monensin

M269 Progesterone intravaginal device and/or calf removal on anestrus Angus/crossbred cows during a 60-day breeding season. J. L. M. Vasconcelos*, G. C. Perez, R. M. Santos, A. T. N. Silva, and A. B. B. Maciel, *FMVZ-UNESP Botucatu, SP, Brazil.*

The aim was to evaluate if treatment with a progesterone device and/or calf removal before the beginning of the 60-day breeding season (BS) could improve reproductive parameters in anestrus Angus/crossbred cows. Anestrus cows (n=286), 53±5 days postpartum (DPP), body condition scores (BCS) between 2.5 to 3.5 (1-5) were assigned to 4 groups: G1 (n=73) Control; G2 (n=70) calf removal (CR) for 48h; G3 (n=73) intravaginal progesterone device (CIDR(r)) for 7 days; G4

(n=70) CIDR for 7 days and CR for 48h. All groups were subject to AI 12h after heat detection. Ovarian structures and pregnancy were evaluated by ultrasound (Aloka SSD-500). BCS and cyclicity (evaluated by two ultrasound examinations 10 days apart) were determined before the beginning of BS. Data were analyzed by GLM, and the parameters included in the model were DPP, treatment, calf gender, BCS, and interactions. Cows bred during the BS were not affected by treatment: G1-53.3%; G2-64.1%; G3-56.5%; G4-64.5%. Number of days and conception to first IA were affected ($P<0.01$) by treatment: G1-28.5d; 45.7%; G2-13.3d; 29.3%; G3-26.9d; 50.9%; G4-9.6d; 76.6%, respectively. Treatment affected the number of days to conception (G1-34.3d; G2-40.5d; G3-36.4d; G4-13.0d; $P<0.01$), but not the percentage of cows pregnant at the end of the BS (G1-43.5%; G2-41.1%; G3-38.8% G4-45.5%). Conception at first AI and percentage of pregnant cows at the end of the BS were affected by BCS (2.5-40.2%; 20.4%; 2.75-42.5%; 37.5%; 3.0-41.6%; 40.7%; 3.25-56.8%; 54.1%; 3.5-72.0%; 58.3%; $P<0.05$), respectively. These data suggest that treatments G2 and G4 decrease the number of days to first AI, comparing with G1 and G3 (13.3d; 9.6d vs. 28.5d; 26.9d) respectively, but G2 had a decrease in conception (29.3%). Thus combining calf removal with CIDR insertion is a good strategy to induce fertile estrous and to enhance early season pregnancy. The responses may be even higher in cows with better body condition score.

Key Words: CIDR, Calf Removal, Short Cycle

M270 Effect of subluteal concentrations of progesterone on an estradiol cypionate induced LH surge in lactating Holstein cows. T. B. Hatler*, D. L. Ray, S. H. Hayes, and W. J. Silvia, *Department of Animal Science, University of Kentucky, Lexington.*

Intermediate circulating concentrations of progesterone (INT P4: 0.1-1.0 ng/ml) are often associated with ovarian follicular cysts in lactating dairy cows. The following experiment was conducted to determine if INT P4 during the follicular phase affected the occurrence of a LH surge induced by estradiol cypionate (ECP). Eazi-Breed CIDRs (1.38 g of progesterone) were preincubated in host cows for either 0, 14 or 28 days (CIDR-0, CIDR-14, CIDR-28, respectively) for subsequent use in this experiment. Ovaries of lactating Holstein cows were examined by transrectal ultrasonography to identify those with a corpus luteum (CL). Luteal function was later verified by RIA for P4 (>3.0 ng/ml). Within 24 hours of CL detection, preincubated CIDRs were inserted into 15 cows (n=5 per preincubation time). The day of CIDR insertion was designated as experimental day -1. Four cows received no CIDRs and served as controls (CONT). CIDRs remained in place for the following 3.5 days. Luteolysis was induced with 2 injections of PGF 2α (Lutalyse, 25 mg, i.m.) given at 6 PM on day -1 and at 6 AM on day 0. Plasma samples were collected from day -1 to 2.5 at 12 hour intervals to measure P4. At 6 AM on day 1, an injection of ECP (3 mg, i.m.) was administered. Blood samples were collected via jugular venous catheter every 2 hours for the next 36 hours to detect the LH surge. The average circulating concentration of progesterone in the four samples collected on

days 1 and 2 was calculated for each cow. The mean P4 concentrations were 1.20, 0.78, 0.45, and 0.11 ng/ml for cows treated with CIDR-0, CIDR-14, CIDR-28 and CONT, respectively ($P<0.01$). Treatment altered the occurrence of the ECP-induced LH surge ($P<0.01$). In all 4 CONT cows, the LH surge was detected an average of 18 hours after ECP injection. LH surges were not detected in any of the 5 CIDR-0 cows. The surge of LH was detected in 2 of 5 CIDR-14 and 4 of 5 CIDR-28 cows, respectively. It was concluded that intermediate progesterone during the follicular phase may contribute to cyst formation by blocking the estradiol-induced LH surge.

Key Words: Progesterone, Ovarian Follicular Cyst, LH Surge

M271 Effect of subluteal concentrations of progesterone on follicular phase events in lactating Holstein cows. T. B. Hatler*, D. L. Ray, S. H. Hayes, and W. J. Silvia, *Department of Animal Sciences, University of Kentucky, Lexington.*

Intermediate circulating concentrations of progesterone (INT P4: 0.1-1.0 ng/ml) are often associated with ovarian follicular cysts in lactating dairy cows. The following experiment was conducted to determine if INT P4 during the follicular phase prevented ovulation. In order to synchronize ovarian events, lactating Holstein cows were administered 2 injections of PGF 2α (Lutalyse, 25 mg, i.m.) 14 d apart. An injection of GnRH (Factrel, 100 μ g, i.m.) was administered 12 d later (designated experimental d 0). Daily transrectal ultrasonography of ovaries and collection of blood samples (for quantification of P4) began on d 0 and continued for the next 22 d. Eazi-Breed CIDRs (1.38 g of progesterone) were preincubated in host cows for either 0, 14 or 28 d (CIDR-0, CIDR-14, CIDR-28, respectively) for subsequent use in this experiment. On d 7(AM), preincubated CIDRs were inserted (CIDR-0 (n=5), CIDR-14 (n=5), CIDR-28 (n=6)) and left in place until the conclusion of the experiment. Cows without CIDRs served as untreated controls (CONT; n=4). Luteolysis was induced with 2 injections of Lutalyse (25 mg, i.m.) given 12 h apart on d 7 and 8. Jugular venous blood samples were collected every 4 h from 8 AM on d 9 to 8 AM on d 14 to detect the LH surge. Treatment with preincubated CIDRs during the follicular phase altered ($P>0.01$) the frequency of ovulation. Ovulation occurred in 0/5 and 1/5 cows treated with CIDR-0 and CIDR-14 while ovulation occurred in 3/6 and 4/4 cows treated with CIDR-28 and CONT, respectively. Preovulatory surges of LH were detected in all cows that ovulated and were not detected in any cows that did not ovulate. On average, LH surges were detected on d 11. Follicular phase concentrations of P4 were determined by calculating the average of P4 concentrations on d 9 thru 11. Circulating concentrations of P4 during the follicular phase were 1.25, 0.71, 0.36 and 0.14 ng/ml for CIDR-0, CIDR-14, CIDR-28 and CONT, respectively. Intermediate progesterone during the follicular phase may contribute to the formation of cysts by blocking the LH surge and thus, ovulation.

Key Words: Progesterone, Ovarian Follicular Cyst, LH Surge

PSA-Environment and Management

M272 Comparative study of body characteristics of broiler chickens from different rearing systems. A. O. Best*, W. L. Willis, and C. Murray, *Department of Animal Sciences, North Carolina A&T State University, Greensboro.*

An experiment was conducted to investigate the relationship between certain body characteristics and growth performance of broiler chickens subjected to different systems of rearing. Two hundred forty female day old broiler chicks were obtained from a local commercial hatchery, and divided into groups of 40. Each group was subjected to one of the following rearing systems: 1) battery cage-no heat; 2) battery cage-heat; 3) floor pens-no heat; 4) floor pens-heat; 5) pasture poultry-no heat and 6) floor pens/pasture. At seven weeks of age, whole carcass, bursa, gizzard, liver, spleen, stomach, and heart weights were taken. Abdominal and leg lengths were measured, and intestines lesion scores were observed. Although all birds were of the same age, their body characteristics were variable for each rearing system. Treatment 4, floor pens-heat, had the highest average body carcass weight (2.53 kg) and the lowest came from treatment 1, battery cage-no heat (1.37 kg). The bursa weights which reflect the health status of broilers in most treatments were above average, ranging from 0.20 (trt. 4) to 0.37 gms (trt.1). The mortality

rate was highest in the pastured poultry system (trt. 5). The results of this study indicate that different rearing systems influence the body characteristics such as organ weights, carcass weights and abdominal length.

Key Words: Body Characteristics, Broilers, Rearing Systems

M273 *Campylobacter Jejuni* Assessment in Organic vs. Conventional Reared Broiler Chickens. L. T. Donaldson*, W. L. Willis, and C. Murray, *Department of Animal Sciences, North Carolina A&T State University.*

An experiment was conducted to investigate the prevalence of *Campylobacter jejuni* in broiler chickens that were produced and marketed as organic or conventional. Trials were performed during the summer and winter utilizing three farms, each of which practice, organic or conventional rearing. Ten broilers from each farm were collected in the processing plant and subjected to carcass rinse (serial dilutions), crop swabbing, ceca swabbing and drug sensitivity prior to evisceration and after chilling. The prevalence of *Campylobacter jejuni* in organically

produced broilers vs conventional was very similar (93 vs 97%) respectively during the summer, but the percentage of positive conventional reared broilers was lower during the winter (77 vs 100% in organically reared broilers). The viable count for *Campylobacter jejuni* in conventional broilers showed a reduction during the winter from 27.3 to 15.3 cfus; whereas, the count in organic broilers increased during the winter from 28.3 to 58.9 cfus. The crop and ceca positive isolates were similar for both rearing systems. The drug sensitivity profile comparison did not differ greatly. Salmonella was found in 91% of the broiler fecal samples collected at the organic farms, while 81% of the samples were positive from the conventional reared broilers. The results from this study showed that organically produced poultry maybe highly contaminated with *Campylobacter jejuni* and care in handling should be encouraged to prevent foodborne illness in humans.

Key Words: *Campylobacter jejuni*, Broilers, Organic

M275 Effect of molting on *in vitro* tissue invasion by *Salmonella enteritidis*. R. W. Moore* and P. S. Holt, *United States Department of Agriculture, Agricultural Research Service, Southeast Poultry Research Laboratory, Athens, GA.*

A tissue culture was utilized to compare tissue cell invasion by *Salmonella enteritidis* from molted and full feed hens. Three identical trials were performed in which 80 wk-old active laying hens were divided into two groups of 6 birds each. The molted hen group was subjected to a 14 day feed withdrawal and full fed hen group was administered a standard layer ration. After feed treatment, crop, ileum, cecum, and ovary (small and large yellow follicles removed) were collected, rinsed in PBS, and placed into 50 mL of RPMI medium. The ends of intestine and crop tissues were tied to allow attachment of *Salmonella* only to the lumen surface. RPMI medium containing 10^7 - 10^8 CFU of novobiocin (NO) and nalidixic acid (NA) resistant phage type 13 *Salmonella enteritidis* was injected into the lumen of the intestine and crop tissues. Additionally, ovaries were incubated in 50 mL of RPMI medium containing 10^6 - 10^7 CFU of the *Salmonella enteritidis*. Tissues were incubated with *Salmonella* at 37°C for 2 hr, after which tissues were placed in 50 mL of fresh RPMI medium containing 500 µg/mL of gentamycin and incubated for 5 hr at 37°C to remove any *Salmonella* which had not penetrated tissues. Tissues were rinsed, stomached in 10 mL of PBS, serially diluted, and plated onto Brilliant Green agar containing 25 µg/mL NO and 20 µg/mL NA for *Salmonella* enumeration. *Salmonella* invasion of ovaries was reduced in tissues from molted hens in trials 1 and 2 as compared to full fed controls (> 1.2 log reduction), but not in trial 3. *Salmonella* invasion of ceca from molted hens was numerically increased in trials 1 and 2 and significantly increased in trial 3 as compared to controls (> 0.8 log increase). No significant differences in *Salmonella* invasion was determined for crops and ileum. These data suggest that molting may effect invasion of tissues by *Salmonella enteritidis*.

Key Words: *Salmonella Enteritidis*, Molt, Invasion

M276 Influence of experimental chlorate product (ECP) in drinking water on environment of the gastrointestinal tract and *Salmonella enteritidis* (SE) in laying hens during an induced molt. L. F. Kubena*¹, J. L. McReynolds¹, J. A. Byrd¹, R. C. Anderson¹, S. C. Ricke², and D. J. Nisbet¹, ¹USDA-ARS, SPARC, Food & Feed Safety Research Unit, College Station, TX, ²Department of Poultry Science, Texas A & M University, College Station.

The use of feed deprivation to induce molting and stimulate multiple egg-laying cycles in laying hens is a common practice in commercial egg production. Unfortunately, an increased risk of *Salmonella enteritidis* (SE) may result; therefore, alternative methods are needed. Hens over 50 wk of age were placed in individual laying cages, with 3 groups of 11 hens per treatment. Two wk prior to dietary changes, hens received an 8-h light and 16 h-dark photoperiod that continued for the 9-day experiment. All hens were challenged orally with 10^6 cfu of SE on day 4 of the study. Treatments were non-fed hens with distilled water (NFD), non-fed hens with the experimental chlorate product (ECP which provided 15mM chlorate ion concentration water; NFECP), alfalfa diets with distilled water (ALD), and alfalfa diets with ECP water (ALECP). When compared with the NFD hens, no significant changes in the pH of the crop or in the lactic acid concentrations of the crop and ceca for the NFECP or ALD hens occurred; however, the lactic acid concentrations were higher in the ALECP hens. Also, there were increases

in the concentrations of propionic acid and total volatile fatty acids of the ceca in the NFECP, ALD, and ALECP hens. When compared with NFD hens, the numbers of SE positive crop and ceca were reduced in the NFECP hens (67%, 35%), ALD hens (9%, 0%), and ALECP hens (84%, 59%). The ECP reduced invasion of the liver, spleen, and ovaries by more than 50%. The intake of alfalfa was low in this study and most likely accounts for the lowered protection against SE. Results suggest that ECP added to the drinking water may be a useful tool to reduce the risk of SE during an induced molt by feed deprivation or the use of alfalfa molting diets. The combination of ECP and the alfalfa molting diet was the most efficacious for several parameters, indicating that an active fermentation during molting is an important factor in maintaining a hostile environment for enteropathogens.

Key Words: Laying Hens, Molting, Experimental Chlorate Product

M277 Impact of the laying hen cycle and molting on the prevalence and populations of *Salmonella*. X. Li*, J. B. Payne, F. B. O. Santos, K. E. Anderson, and B. W. Sheldon, *Department of Poultry Science, North Carolina State University, Raleigh.*

Salmonella species are recognized as major foodborne pathogens that are closely associated with the consumption of contaminated poultry and egg products. The objective of this study was to determine whether the hen's laying cycle and feed withdrawal (molting) influence the prevalence and populations of *Salmonella* in the feces. Composite fecal samples were periodically taken from a commercial layer complex containing multiple houses. Each house contained 90,000 hens housed in 2700 cages arranged across 6 rows. Composite fecal samples across each row were collected from different houses as a function of bird age [18 wks (pullets housed), 25 to 28 wks (1st production cycle), 65 to 74 wks [molting] and 75 to 78 wks (2nd production cycle)]. Populations of *Salmonella* spp. were enumerated using a MPN (most probable number) procedure. House temperatures and ammonia levels were recorded at each sampling time. For 18-week birds, *Salmonella* populations ranged from log 1.81 to 1.97 MPN per g with 55.6% of the samples testing positive (n = 18). For the 25 to 28-week birds, *Salmonella* populations ranged from log 1.34 to 2.73 MPN per g with 41.7% testing positive (n = 24). No *Salmonella* (<1 log) were detected in the feces from 65 to 74-week (n = 12) and 75 to 78-week birds (n = 6). The average ammonia levels were 13.3, 55.0, 20.0 and 20.0 ppm for houses containing the 18, 25 to 28, 65 to 74 and 75 to 78-week old birds, respectively. The 18-week old birds had the highest incidence of *Salmonella*-positive (55.6%) samples but the lowest average ammonia levels whereas the 25 to 28-week old birds had the highest average population of *Salmonella* (log 2.73 MPN per g) and highest ammonia levels. These results indicate that layer age and feed withdrawal (molting) did impact both the incidence and populations of *Salmonella* recovered from layer feces. Moreover, feed withdrawal molting practices did not appear to increase the incidence or shedding of *Salmonella* in the feces.

Key Words: *Salmonella*, Production Cycle, Molting

M278 Late post-molt egg production in laying hens molted with different rations of alfalfa and layer ration. L. M. Donalson*¹, W. K. Kim¹, C. L. Woodward¹, P. Herrera¹, L. F. Kubena², D. J. Nisbet², and S. C. Ricke¹, ¹Department of Poultry Science, Texas A&M University, College Station, ²USDA Agricultural Research Service, College Station, TX.

A total of 116 White Leghorn laying hens were induced to molt after being acclimated and monitored for pre-molt egg production. The hens were then divided into five treatment groups: full fed (FF), feed withdrawal (FW), 100% alfalfa (A100), 90% alfalfa / 10% layer ration (A90), and 70% alfalfa / 30% layer ration (A70). The hens were put on a lighting program and molted for 9 days. At the end of the molt, 56 birds were euthanized and organ weights were taken while the other 60 were returned to a layer ration and evaluated for post-molt performance. Parameters examined included: egg height, egg weight, albumen height, yolk height, yolk diameter, shell breakage, specific gravity and overall egg production. Overall egg production was significantly lower (P<0.05) at week 17 when FF treatment birds were compared to A90, A100 and NF birds. At weeks 21 and 23 FF birds were significantly different than NF birds. At week 26, A100 birds had significantly shorter egg lengths than all other treatments. The yolk diameters from A70 birds were significantly smaller at week 22 than all other treatments. The yolk heights were significantly smaller in NF birds at weeks 24, 35 and 38

when compared to FF birds. FF birds had significantly lower albumen height measurements at weeks 17, 18, 23, 24, 25, 27 and 28 when compared to NF and at weeks 29 and 34 when compared to A70 and A90 respectively. A70 birds showed significantly higher egg weights at weeks 21, 24, 26, 27, 29, 33 and 34 when compared to A100 and at weeks 21, 27, 30, 31 and 33 when compared to FF. When shell breakage strengths were compared, A90 proved to be significantly stronger than A100, FF, and A70 at weeks 22, 24, and 30 respectively. Specific gravity for A90 also proved to be significantly higher than A70 and A100 at weeks 24 and 32.

Key Words: Molting, Egg Quality, Alfalfa

M279 Evaluating bone and eggshell parameters of molted hens at the end of 2nd laying cycle compared to non-molted hens. W. K. Kim*¹, L. M. Donalson¹, P. Herrera¹, C. L. Woodward¹, L. F. Kubena², D. J. Nisbet², and S. C. Ricke¹, ¹Texas A & M University, College Station, ²USDA-ARS, Southern Plains Agricultural Research Center, College Station, TX.

A study was conducted to evaluate bone and eggshell parameters of molted hens at the end of 2nd laying cycle. Osteoporosis in laying hens is important animal welfare issue as well as economic issue for the poultry industry. Osteoporosis in laying hens is defined as a condition that involves the progressive structural bone loss. Osteoporosis is one of the main reasons of subsequent fractures in laying hens. An induced molt using feed withdrawal is a potential factor increasing structural bone loss and the incident of osteoporosis in old laying hens. The objectives of this study were 1) to evaluate bone and eggshell parameters of molted hens at the end of 2nd laying cycle and 2) to evaluate the relationship between eggshell and bone parameters. A total of 60 Single Comb White Leghorn hens were used for this study. There were two controls and four molting treatments: full-fed control 1 (82 wk old) (FF1), full-fed control 2 (122 wk old) (FF2), feed withdrawal (FW), 100% alfalfa (A100), 90% alfalfa/10% layer ration (A90), and 70% alfalfa/30% layer ration (A70). At the end of the 2nd laying cycle (approximately 122 wk of age), eggs were collected, and then hens were euthanized by CO₂ to collect left tibia and femur. The tibia percent ash of the FF1 was significantly higher than the A90. The tibia ash concentration of the FF1 was significantly higher compared to the FW, A100, and A90 (P<0.05). The FF1 had a significantly greater femur percent ash than the A90 (P<0.05). In the eggshell parameters, the FF1 had significantly higher shell weight, percent shell, and shell thickness compared to the A100 (P<0.05). However, the egg weight of the FW was significantly heavier than the FF1 (P<0.05). The correlation analysis showed that overall bone parameters were negatively correlated with eggshell parameters. These results suggest that age of hens and molting practice have an impact on bone status of hens at the end of 2nd laying cycle, and eggshell formation is closely related to bone metabolism in laying hens.

Key Words: Molting, Bone Parameters, Eggshell

M280 Reduction of *Salmonella typhimurium* (ST) yeast agglutination and intestinal colonization in broilers by galactose or mannose liberated from guar gum. J. T. Lee*, S. E. Tichy, C. A. Bailey, A. L. Cartwright, and D. J. Caldwell, Texas A&M University System.

Several laboratories have reported on the ability mannose, administered by feed or drinking water, to interfere with *Salmonella* intestinal colonization in commercial poultry. Guar gum has a mannose backbone with galactose bound to alternating mannose sugars. The mannose:galactose ratio in guar gum is approximately 2:1. Addition of Hemicell[®], a galactomannanase, hydrolyzes the gum to produce mannose monomers and oligosaccharides as verified by the Matrix Assisted Laser Desorption and Ionization (MALDI) procedure. The objective of the present experiments was to investigate the ability of hydrolyzed guar gum to reduce the ST intestinal colonization in broiler chicks. First, an *in vitro* yeast agglutination test was performed to investigate the ability of hydrolyzed guar gum solution (4.5%) to prevent ST agglutination of yeast cells. Mannose and galactose solutions were used as positive and negative controls, respectively. Hydrolyzed guar gum solutions were as effective as mannose at inhibiting the ability of ST to agglutinate yeast cells while galactose had no inhibitory effect on agglutination. Two duplicate *in vivo* experiments were performed to determine the inhibitory ability of hydrolyzed guar gum, mannose, and galactose on ST cecal colonization (Log₁₀ ST cfu/g) in broiler chickens. Experiment 1 indicated galactose

(2.18 cfu/g) significantly (P<0.05) reduced ST cfu recovered from broilers while mannose (3.88 cfu/g) and hydrolyzed guar gum (2.40 cfu/g) did not differ from control (3.37 cfu/g). In experiment 2, mannose (0.82 cfu/g) and galactose (1.24 cfu/g) fed broilers significantly reduced ST recovered from the ceca while no difference was observed between control (2.23 cfu/g) and hydrolyzed guar gum treatments (2.10 cfu/g). These experiments indicate that both mannose and galactose interfere with the ability of ST to agglutinate yeast cells *in vitro* and colonize the ceca of broilers.

Key Words: Galactose, Guar Gum, Mannose

M281 Attachment of *Salmonella* and *Campylobacter* spp., to chicken spermatozoa viewed by scanning electron microscopy. N. A. Cox¹, J. S. Bailey¹, D. E. Cosby*¹, R. J. Buhr¹, L. J. Richardson¹, J. L. Wilson², D. V. Bourassa², W. L. Steffans³, and M. B. Ard³, ¹U. S. Department of Agriculture, Russell Research Center, Athens, GA, ²Department of Poultry Science, University of Georgia, Athens, ³Department of Veterinary Pathology, University of Georgia, Athens.

We previously demonstrated that vertical transmission of *Campylobacter* could occur. The mechanism of this transmission is still unclear. Previously negative broiler breeder flocks have been reported to become positive with the introduction of spike roosters at 45 wk of age. To determine if the rooster semen is a possible source of transmission to hens for colonization, we evaluated the association of both *Campylobacter* and *Salmonella* spp., to segments (head, mid-piece and tail) of individual spermatozoa after artificial inoculation. Three strains of *Salmonella* (Typhimurium, Heidelberg and Montevideo) or one strain of *Campylobacter jejuni* (in 0.85% saline) was added to a freshly collected (by abdominal massage) aliquot of pooled semen from roosters housed in individual cages. The semen-bacteria solutions were incubated 1 hour at room temperature. Samples were fixed in 2% (para)formaldehyde, 2% glutaraldehyde, 0.2% picric acid in 0.1 M Cacodylate-HCl buffer, pH 7.25, for 24 hours prior to centrifuging and rinsing in the 0.1 M Cacodylate-HCl buffer. Individual aliquot samples were placed on coverslips and allowed to settle overnight in a wet chamber. Samples were taken through an ethanol gradient and critical point dried in an Autosamdri-814 Critical Point Dryer. After drying, the coverslips were mounted and sputter coated with 300 angstroms of gold with the SPI-Module Sputter Coater. The samples were then viewed with a JSM-5800 Scanning Electron Microscope. *Salmonella* was found associated to all three segments (head, mid-piece and tail) of the spermatozoa apparently equally distributed. *Campylobacter* was mainly associated with the mid-piece and tail segments, with few located on the head segment. Further work is planned to determine if the adherence is actually attachment.

Key Words: *Salmonella*, *Campylobacter*, Spermatozoa

M282 Efficacy of Sal CURB[®] brand ASF liquid antimicrobial against various *Salmonella* species in a meat and bone meal matrix. M. L. Burke*, J. K. Murphy, and V. J. H. Sewalt, Kemin Americas, Inc., Des Moines, IA.

Sal CURB[®] brand ASF liquid antimicrobial (SC ASF) is a formaldehyde-based product that is used to maintain feeds and feed ingredients *Salmonella*-negative for up to 21 d. Previous work has demonstrated that an application rate of 6.5 lbs/ton of SC ASF is sufficient to eliminate *Salmonella* from corn/soy feed (Welch et al., 2003). Its efficacy against various *Salmonella* species in a high protein matrix, such as meat and bone meal, has not been fully explored. The purpose of this experiment was to evaluate the efficacy of SC ASF against *Salmonella typhimurium* ATCC 14028, *Salmonella senftenberg* ATCC 43845, *Salmonella montevideo* ATCC 8387, and *Salmonella enteritidis* ATCC 13076 in a meat and bone meal matrix. These strains, combined in the form of a lyophilized culture, were used to inoculate sterilized meat and bone meal at 1,500 CFU/g. The meat and bone meal was treated with 6.5, 9, 12 and 15 lb/ton of SC ASF. Samples were done in triplicate. A positive control and negative control were included in the study. The efficacy of SC ASF against *Salmonella* was determined by assaying for *Salmonella* via the FDA BAM methodology on Day 1 post-treatment, post-inoculation. Testing on Day 1 revealed that 12 and 15 lb/ton of SC ASF were sufficient to eliminate *Salmonella* in all replicates, and 9 lb/ton killed the *Salmonella* in two of the three replicates. Further studies are required to confirm if Sal CURB ASF can maintain

meat and bone meal Salmonella-free after re-exposure. Results of this study demonstrate that at least 9 lb/ton of Sal CURB[®] brand ASF liquid antimicrobial is required to effectively eliminate Salmonella in high protein matrices such as meat and bone meal, contrary to corn/soy feed, in which 6.5 lb/ton is sufficient.

Key Words: Sal CURB ASF, Salmonella, Meat and Bone Meal

M283 Effect of storage time on *Campylobacter jejuni* isolation and drug sensitivity in broiler wings. W. L. Willis*, K. Smith, and C. Murray, *Department of Animal Sciences, North Carolina A&T State University, Greensboro.*

An experiment was conducted to determine the effect of storage time on the isolation and drug sensitivity of *Campylobacter jejuni* (C.j.) from broiler wings subjected to a commercial antimicrobial treatment. In trial one, wings (2 each) were collected from 64 whole carcasses in a commercial processing plant produced as organic or conventional during the summer and winter. They were subjected to an antimicrobial treatment after chilling. The wings were pooled, placed into zip-locked storage bags, stored in the refrigerator for 1, 5, 10, and 15 days, then swabbed. Swabbs were plated on BBL blood Agar and incubated at 42° C for 24-48 hr then tested for C.j. presence and drug sensitivity. Disk-diffusion for drug sensitivity utilized five antimicrobials (enrofloxacin, erythromycin, gentamicin, tetracycline, and naladixic acid). In trial two, 8 non-commercial chicken wings from pastured and 8 conventional reared poultry were processed without an antimicrobial treatment. The wings were stored in a Campy-gas mixture and refrigerated for 1, 5, 10, and 15 days. The results from trial one showed no difference in the isolation of C.j. at 1, 5, or 10 days regardless of how they were raised or the storage time. C.j. could not be isolated from any 15 day samples. Trial 2 results were similar with almost 100 percent isolation, except for day 15. The treated wings showed a greater reduction ($P < 0.05$) in positive samples when compared to non-treated. C.j. was more susceptible to tetracycline than other drugs. There was a trend for 10-day C.j. isolates to become more susceptible to erythromycin. The results suggest that extended storage time affects the isolation of C.j. and drug sensitivity. Moreover, it was concluded that the antimicrobial treatment reduced C.j.

M284 Effect of Immustim[®] and Protimax[®] on *Campylobacter jejuni* and *Salmonella typhimurium* Populations in Broilers. J. Spruill*, R. Plunsk, J. Grimes, P. Ferket, and B. Sheldon, *North Carolina State University, Raleigh.*

The objective of study 1 was to estimate the populations of *S. typhimurium* (S) and *C. jejuni* (C) in the GI tracts of broilers fed a diet containing beta-1,3/1,6-glucan (Immustim[®]). Study 2 evaluated the effects of a diet containing a spray-dried egg product from immunized hens (Protimax[®]) on intestinal S and C populations. Both studies consisted of the same experimental design. Chicks (720) were placed 10/pen (12 pens/battery) in 3 rooms (2 batteries/room). C- and S-challenged and non-challenged chicks were housed in separate rooms. Pens were randomly assigned 1 of 3 feed treatments added to a standard starter feed. Dietary Immustim[®] levels were 0, 20 or 40g/ton. Feed treatments for the second study consisted of a negative control (a standard starter feed), a positive control (a spray-dried egg product without immunoglobulins) and Protimax[®] (both at 6kg/ton). In study 1, 3-day old chicks were gavaged with 1mL of 10⁶ cfu/mL of a nalidixic acid-resistant S strain. The C challenge (1mL of 10⁶ cfu/mL) occurred at 14d. Lower GI tract and cecal samples were collected on 7, 14, 17 (C only) and 21d. In study 2, chicks were gavaged with S at 7d and C at 14d. Samples were removed on 14, 21 and 28d. The samples were serially diluted and spiral plated (50µL) onto BHI agar, BHI agar with 800ppm nalidixic acid or Campy Cefex agar. Control plates and those plates estimating S growth were incubated at 37C for 24h, while C plates remained in a 42C incubator for 48h under microaerophilic conditions. Data were analyzed using GLM of SAS with means separated using LS Means ($P \leq 0.05$). Neither feed treatment affected broiler GI tract S or C populations. Improved bird performance was observed for non-challenged birds fed Immustim[®]. S-challenged birds showed improvement in growth and FC at 20g/ton of Immustim[®], while birds challenged with C showed improved growth when fed 40g/ton. The addition of Protimax[®] resulted in reduced growth for C-challenged birds. However, Protimax[®] improved FC for S-challenged birds, but had no effect on non-challenged birds.

M285 Acidified Sodium Chlorite application in the drinking water to control Salmonella colonization in market age broilers. P. Mohyla*¹, S. F. Bilgili¹, D. E. Conner¹, C. C. Warf², and G. K. Kemp², ¹*Auburn University, Auburn,* ²*Alcide Corporation, Redmond, WA.*

Acidified sodium chlorite (ASC; SANOVATM) is approved as a carcass disinfectant in poultry processing. ASC is produced by combining sodium chlorite (SC) and citric acid (CA). Under low pH, SC forms chlorous acid, a bactericidal oxychlorine species. Efficacy of ASC in reducing Salmonella colonization in broilers was determined. ASC was prepared either by adding CA or sodium acid sulfate (SAS). Two hundred and forty broilers (35 days of age) were randomly allocated to four Petersime batteries (5 birds/pen, 12 pens/battery). Study involved 12 treatments: negative control (plain water-no challenge), positive control (plain water-challenged), and five concentrations (0, 150 ppm, 300 ppm, 600 ppm and 1200 ppm) of SC, acidified to pH of 2.6 ± 0.1 either with CA or SAS. All birds, except for the controls, were fasted for two hours and orally gavaged with 104 CFU/ml of *Salmonella typhimurium* one hour before the initiation of treatments. Treatments were freshly mixed and replaced every 4 hours. Live performance (body weight, water consumption and weight gain/loss) was measured during the 24 hour experimental period. All 240 birds were then necropsied, digestive tracts were aseptically removed, split into 3 segments of upper (crop to gizzard), middle (duodenum to cecal junction) and lower (ceca to cloaca) for *Salmonella* enumeration (CFU/g). No significant ($P > 0.05$) changes were found in body weight, weight gain and in the appearance/color of the excreta. There was no significant acidifier (CA vs. SAS) effect on water consumption or *Salmonella* counts. However, a significant ($P < 0.05$) concentration effect for ASC was detected, where levels beyond 600 ppm negatively affected water consumption. ASC reduced *Salmonella* in the upper segment of the digestive tract linearly ($P < 0.05$) with increasing concentrations. Levels of ASC to reduce *Salmonella* in the middle and lower digestive tract segments were >600 and 1200 ppm, respectively. Pre-slaughter inclusion of ASC in the drinking water may be an effective way to reduce foodborne pathogens in poultry.

Key Words: Broilers, Acidified Sodium Chlorite, Salmonella

M286 Changes in intestinal microbiota and ileal susceptibility to pathogen attachment in broilers subjected to 24 hr heat stress. K. B. Selig* and J. A. Patterson, *Purdue University, West Lafayette, IN.*

The intestinal microbiota in chickens can be altered during periods of stress, which may contribute to intestinal susceptibility to pathogen colonization. The objectives of this study were to determine the effect of 24 hr heat stress on the microbial community structure of broilers and the susceptibility of intestinal tissues to colonization by *Salmonella enteritidis*. Male broilers were raised for six weeks in floor pens, fed standard corn-soybean meal diets and were adapted to normal (74 degrees F) temperatures as part of another study. At six weeks of age, randomly selected birds were subjected to 86 degrees F for 24 hr, then control and heat stressed birds (10 per treatment) were killed by carbon dioxide asphyxiation and intestinal contents and tissues were sampled. Changes in microbial community structure were determined using denaturing gradient gel electrophoresis separation of the V3 region of 16S ribosomal DNA extracted from luminal and mucosal wall associated intestinal bacteria. An in vitro ileal loop assay was used to determine the susceptibility of intestinal tissue to colonization by *Salmonella enteritidis*. The similarity index of ileal communities from birds within the heat stressed treatment was significantly lower (55% similarity coefficient) than from birds within the control treatment (65% similarity coefficient). The similarity index between heat-stressed and control treatments (41% similarity coefficient) was lower than the similarity indexes within either treatment ($p < 0.05$). *Salmonella enteritidis* attachment to ileal tissues in the in vitro attachment assay was 1.9 fold higher in tissues from heat stressed birds compared to tissues from control birds (8.77 vs. 8.50 log₁₀ cfu/g, respectively; $p < 0.05$). The data indicate that stress-induced alterations of the intestinal tract create opportunities for pathogen colonization by altering both the protective microbiota populations and by altering the epithelial susceptibility to attachment.

Key Words: Poultry, Intestinal Microbiota, Salmonella Enteritidis

M287 Case Study: The effect of drinking water treated with KEM SAN™ brand liquid acidifier on the livability of breeder candidates. J. K. Murphy*¹, P. A. Welch², and V. J. H. Sewalt¹, ¹Kemin Americas, Inc., Des Moines, IA, ²Nutritional Services Consulting, LLC, Laurel, MS.

KEM SAN™ brand liquid acidifier (KEM SAN) is an EPA-registered water sanitizer for the control of bacteria in poultry drinking water. KEM SAN treated drinking water has been demonstrated to improve livability, reduce plant condemnations, and improve feed efficiency in broilers (Welch et al., 2003; 2004). The purpose of this field study was to determine the effect of KEM SAN treated drinking water on the livability of breeder candidates. This study was conducted at a large commercial broiler integrator complex using a Ross 344 male x Cobb 500 slow feathering female strain cross. A 33% stock solution of KEM SAN was administered to the drinking water resulting in a final concentration of 2.58 ml/L of KEM SAN in the treated drinking water. KEM SAN treated drinking water was administered to two houses of pullets and rooster chicks continuously for the first 21 days after placement in the first study and the first 8 days after placement in the subsequent two studies. Mortalities were recorded daily and maintained in an M-Tec flock database. Fourteen-day mortality was calculated for each test flock and results were compared with settlement records of 88 previous and contemporary flocks that were not treated with KEM SAN. Pullet mortality was reduced ($P < 0.05$) by 1.10% when chicks were administered KEM SAN treated drinking water for at least the first 8 days following placement when compared to pullets provided untreated drinking water in previous and contemporary flocks. A numerical reduction in mortality was observed in rooster chicks receiving KEM SAN treated drinking water. Results of this study demonstrate that KEM SAN™ brand liquid acidifier administered at a rate of 2.58ml/L to the drinking water of pullets continuously for a period of at least 8 days following placement significantly reduced 14-day pullet mortality.

Key Words: KEM SAN Liquid Acidifier, Pullets, Livability

M288 Comparison of antibiotic resistance frequency of *Salmonella* Typhimurium growth in glucose-limited continuous culture at slow and fast dilution rates. N. Karabasi¹, S. Bulajic¹, W. K. Kim*², K. D. Dunkley², T. R. Callaway³, T. L. Poole³, S. C. Ricke², R. C. Anderson³, and D. J. Nisbet³, ¹University of Belgrade, Belgrade, Serbia-Montenegro, ²Texas A & M University, College Station, ³USDA-ARS, FFSRU, College Station, TX.

The objective of the study was to determine the frequency of spontaneous acquisition of resistance to select antibiotics by *Salmonella* Typhimurium when grown in glucose limited continuous flow culture at slow ($D = 0.025 \text{ h}^{-1}$) or fast ($D = 0.27 \text{ h}^{-1}$) dilution rates. The bacterium was grown in LB minimal medium (pH 6.25) containing no antibiotics. Upon achieving steady state, samples were plated to tryptic soy agar (TSA) alone or supplemented (per ml) with 2 and 16 ug oxytetracycline, 4 and 16 ug tetracycline, 2 and 64 ug kanamycin and 0.25 and 2 ug enrofloxacin. After 24 h incubation at 37C, recovery of *Salmonella* from unsupplemented TSA was 2.3 and 1.6×10^9 CFU for slow and fast growing cultures, respectively. Regardless of growth rate, the likelihood of recovering resistant *Salmonella* from the TSA containing the higher antibiotic concentrations was less than 1 in 10^8 for all antibiotics tested. The likelihood of recovering *Salmonella* from TSA containing 2 ug oxytetracycline/ml was also less than 1 in 10^8 /ml or 0.25 ug enrofloxacin/ml. Tests of representative isolates from the antibiotic supplemented TSA for their susceptibility to these respective antibiotics, using the NAHMS panel, revealed little if any difference in susceptibilities. Since *Salmonella* concentrations in the gut rarely exceed 10^6 CFU/g, these results suggest that in recovery of *Salmonella* from TSA supplemented with 4 ug tetracycline/ml was more likely for cells that had been sampled from the faster rather the slower growing culture (1 in 10^6 versus 1 in 10^8 , respectively). Recovery of *Salmonella* was much more likely (< 1 in 10 regardless of dilution rate) from TSA supplemented with 2 ug kanamycin. These results indicate that alterations in phenotypic expression of resistance appear to not be influenced by flow rate or exposure to lethal or sublethal antibiotic concentrations in this cultivation system.

Key Words: Antibiotic Resistance, *Salmonella* Typhimurium, Continuous Culture

M289 The influence of a fructooligosaccharide (FOS) prebiotic with feed substrates on *in vitro* *Salmonella typhimurium* growth of laying hen cecal bacteria. L. M. Donalson*¹, W. K. Kim¹, P. Herrera¹, C. L. Woodward¹, L. F. Kubena², D. J. Nisbet², and S. C. Ricke¹, ¹Department of Poultry Science Texas A&M University, College Station, ²USDA-ARS, College Station, TX.

The objective of this study was to investigate the effect of combining a prebiotic with feed substrates on the growth of *Salmonella typhimurium* in an *in vitro* model. Cecal contents from three laying hens were pooled and diluted to a 1:3000 concentration in an anaerobic dilution solution. The cecal dilution was added to sterile test tubes filled with alfalfa and grain with and without FOS. Two controls, inoculum only and no inoculum were used. The samples were processed in the anaerobic hood and incubated at 37°C. Samples were inoculated with *Salmonella* at 0, 6 and 24 hours after *in vitro* fermentation then plated at 0, 6 and 24 hours after inoculation. Plates were incubated for 24 hours then counted. Samples inoculated at 0 hours after *in vitro* fermentation increased in *Salmonella* 64-fold from 0 to 6 hours after inoculation (beginning count 10^7 and 10^9 respectively), however between 6 and 24 hours after inoculation, no further significant increase was observed. *Salmonella* counts for inoculum and no inoculum controls 24 hours after inoculation were significantly lower than other treatments ($P < 0.05$). For samples inoculated at 6 hours after *in vitro* fermentation (average initial counts 10^7) *Salmonella* generally grew slowly over time (4.5-fold) with significant differences at 24 hours after inoculation for inoculum and no inoculum when compared to all other treatments. Samples inoculated with *Salmonella* 24 hours after fermentation showed a general decrease of *Salmonella*. At 24 hours after inoculation, grain plus FOS and alfalfa plus FOS samples (average initial counts 10^9) had significantly lower *Salmonella* counts (99.95% and 99.96% respectively). These results show 24 hour *in vitro* cecal fermentation reduced *Salmonella* growth especially when FOS was present.

Key Words: Prebiotic, *In Vitro*, *Salmonella Typhimurium*

M290 Comparison of *Aspergillus* meal or inulin prebiotics as substrates for *Salmonella* or *Lactobacilli* *in vitro*. G. M. Nava*¹, V. Davila², L. Newberry¹, G. Tellez¹, A. M. Donoghue³, and B. M. Hargis¹, ¹University of Arkansas, Fayetteville, ²Universidad Nacional Autonoma de Mexico CEIEPA, FMVZ-UNAM. Mexico City 04510, ³PPPSRU/ARS/USDA, Fayetteville, AR.

The establishment of beneficial microflora, such as *Lactobacilli*, is believed to be important for intestinal health, possibly promoting immune system development, mucosal development, mucosal integrity, and other functions. Prebiotics, or non-digestible dietary microbial substrates, should hypothetically promote the amplification of beneficial microflora, such as *Lactobacilli* while not supporting potential pathogens such as *Salmonella*. Presently, we evaluated the specific growth rate (SGR) of *Lactobacillus casei* or *Salmonella enteritidis* (SE) in basal medium supplemented with either 0.2% (w/v) *Aspergillus* meal (AM) or 0.2% (w/v) of inulin. Each medium was inoculated with approximately 1×10^5 cfu/ml of the target bacteria. Two hundred microliters of each inoculated media were transferred to microtiter-plates and incubated for 10 hours at 37 C. Each hour, the SGR of the respective bacterium was evaluated through optical density using a bio-kinetic reader. In experiment 1, AM or inulin supplementation enhanced ($P < 0.001$) the propagation of *Lactobacillus* when compared to controls. In Experiment 2, either supplementation with either prebiotic (AM or inulin) significantly ($P < 0.001$) reduced SE-SGR when compared to the control without prebiotic. These results suggest that some prebiotic products may specifically enhance the growth of some *Lactobacilli* believed to be beneficial gastrointestinal microflora while simultaneously reducing the growth of harmful pathogenic bacteria (SE). These results are consistent with several recently published *in vivo* studies with these candidate prebiotics and may suggest a role for *in vitro* screening of other candidates or combinations of putative prebiotics.

Key Words: Prebiotic, *Lactobacillus*, *Salmonella*

M291 Antibiotic, prebiotic and probiotic programs for *Salmonella* sp. reduction in chicks, pullets, hens and their eggs. A. St. John*¹, B. Love², D. Shaw², and P. Patterson¹, ¹Department of Poultry Science, The Pennsylvania State University, University Park, ²Department of Veterinary Science, The Pennsylvania State University, University Park.

Salmonella sp. can be responsible for food borne illness among people who ingest contaminated poultry meat and eggs. The efficacy of antibiotics, prebiotics and probiotics or products in combination were evaluated by the level of *Salmonella* reduction in commercial chicks and pullets. Experiment 1 demonstrated that treatment products resulted in a zone of inhibition ranging from 0.0 to 2.5mm on Sensititre plates with *Salmonella* enteritidis phage type 8 (SePT8). The antibiotic Baytril had the greatest inhibition followed by CuSO₄, Gentamycin, Calsporin and four Terpene mixtures (P<0.05). Experiment 2 determined the appropriate SePT8 dose for chicks with recovery and titration in liver, spleen, duodenum, ceca and colon. From this study it was determined that a dose of 0.20ml with 2.0 x 10⁹CFUs/mL was sufficient for a systemic infection to reach all organs. Experiment 3 evaluated promising prebiotics, probiotics and antibiotics for chicks challenged with SePT8. In four trials, the products demonstrated a range of SePT8 reduction in tissues from 21.1% to 98.0% compared to positive controls. Feed intake was not significantly impacted by any of the dietary or drinking water additives (P>0.05). The final experiment evaluated the most promising treatments in 17 and 19 wk old pullets as well as 21 wk old hens. Initial results demonstrated that Baytril, Calsporin, and Terpenes-B and -PL effectively reduced SePT8 in all tissues from 10.3% to 99.8%. In both the 17 and 19 wk studies, all products including the positive and negative controls had no culturable SePT8 in ovarian tissue. In the hen study, tribasic copper chloride and Primalac eliminated SePT8 in all tissues samples, while Terpene-B and Immunomilk reduced SePT8 in tissues from 8.8% to 99.9%. Egg pools from hens during the 7d post inoculation phase were all negative for SePT8. This study identified promising prebiotics, probiotics and antibiotics that reduce the level of SePT8 in commercial Leghorn chicks, pullets, hens and their tissues.

Key Words: Prebiotic, Probiotic, *Salmonella* Enteritidis

M292 Evaluation of alternative host bacteria as vehicles for oral administration of bacteriophages. L. R. Bielke*, S. E. Higgins, K. L. Guenther, G. I. Tellez, and B. M. Hargis, University of Arkansas, Fayetteville.

Survival of bacteriophages (phages) through the upper gastrointestinal tract (GIT) is essential for treatment of enteric infections. Few phages survived the upper GIT of chicks when administered without protection (> 6 log reduction). We selected alternative host bacteria (AHB) that would support amplification of our *Salmonella enteritidis* (SE) phages, and infected these AHB prior to administration by either oral gavage alone or with supplemental administration in the drinking water (DW). Phages (9 log pfu) with AHB (100X dilution of turbid culture) were incubated (10 min) prior to administration. Phages from cecal contents were enumerated using SE overlay plates to determine GIT survival. Wild-type phage isolates WHR8 or WHR10 were individually evaluated in Exp 1. Cecal contents were obtained at 6, 26, or 77 h post-gavage. At 6-h, 7.63 and 7.71 log pfu were recovered when phage was administered via oral gavage only or with supplemental administration in DW, respectively. By 77-h, phage recovery was 2.77 and 1.88 log. Recovery of WHR10 at 6-h was 5.75 log when administered via oral gavage only, additional administration in DW did not increase phage recovery. At 77-h, no detectable phages were recovered in the gavage only group, but 1.97 log were detected when phage and AHB were added in DW. In Exp 2, only WHR10 was evaluated. Phages were administered by gavage alone (G1), combined with AHB and administered by oral gavage only (G2), oral gavage + AHB in DW at 6.35 log/mL (G3) or 5.35 log/mL in DW (G4), or phage + AHB by oral gavage every 12-h (G5). In G1, 4.73 log phages were recovered at 6-h and 1.54 log phages were detected at 72-h. In G2, 5.33 log were recovered at 6-h, and by 72-h, no phages were detected. Addition of phages and AHB in DW (G3 and G4) had no effect on phage recovery when compared to G2. After an initial recovery of 2.36 log in G5, the number of recovered phages remained constant for 72-h. Further selection of AHB and acid-resistant phages may increase the efficacy of phage treatments for *Salmonella* infection.

Key Words: Bacteriophage, Chickens, *Salmonella enteritidis*

M293 Effects of nitrocompounds and feedstuffs on *in vitro* methane production in chicken cecal contents. S. Saengkerdsub*¹, W. K. Kim¹, T. R. Callaway², R. C. Anderson², D. J. Nisbet², and S. C. Ricke¹, ¹Texas A & M University, College Station, ²USDA, Agricultural Research Service, Southern Plains Agricultural Research Center, College Station, TX.

The ceca are the primary site for anaerobic microbial fermentation in chicken. One of the end products of this process is methane. The objective of this study was to examine effects of feedstuff and nitrocompounds on methane production in *in vitro* incubation with laying hen cecal contents. Cecal contents from laying hens were diluted to a 1:20 concentration with anaerobic dilution solution. The cecal dilution was added to serum tubes containing alfalfa or layer feed. There were four treatments: control, 12 mM nitroethane, 12 mM nitroethanol, 12 mM 2-nitropropanol. The samples were incubated at 37 C for 24 hours under CO₂ and H₂ (50:50) gas mixture in closed tubes with 120 mM sodium formate. In alfalfa supplementation, methane production was reduced 99.7 ± 0.0, 99.2 ± 1.0, and 46.6 ± 9.9% (P < 0.05) when nitroethane, nitroethanol, and 2-nitropropanol were added, respectively, compared to controls (59.1 ± 5.3 μmol/g cecal content). Similar to providing alfalfa, methane was reduced 99.0 ± 0.1% in treatments incubated with added feed plus nitroethane or nitroethanol when compared to controls (19.1 ± 1.6 μmol/g cecal content). However, methane production increased 6 and 2 times (P < 0.05) due to alfalfa and feed, respectively. The results indicate that nitroethane and nitroethanol inhibit *in vitro* methane production; conversely, alfalfa and feed promote methane generation in cecal contents of chicken.

Key Words: Methane, Nitrocompound, Microbial Ecology

M294 Incidence of *Clostridium perfringens* in yolk follicles of broiler breeder hens. G. R. Siragusa*¹, N. A. Cox¹, J. S. Bailey¹, L. J. Richardson¹, R. J. Buhr¹, K. L. Hiatt¹, D. E. Cosby¹, J. L. Wilson², and D. V. Bourassa², ¹USDA-ARS, Russell Research Center, ²Department of Poultry Science, University of Georgia, Athens.

Subtypes of *Clostridium perfringens* are a major cause of human food borne gastroenteritis as well as the poultry disease necrotic enteritis. The natural presence of *C. perfringens* in individual mature and immature yolk follicles and the homologous ceca from 66 and 60 week old broiler breeder hens were determined from two different commercial facilities. In accordance with humane animal treatment guidelines, hens were transported for overnight holding and processing at the University of Georgia. Using extraordinary measures to reduce external as well as cross contamination, immature/mature yolk follicles and the corresponding ceca were aseptically removed. Samples were placed into individual stomacher bags, and immediately transported to our laboratory for within-the-hour analysis. Analytical determinations were based on non-selective enrichment culture followed by both cultural and PCR based tests. In the first trial, *C. perfringens* was detected and isolated from all ceca (n=8) and from only a single immature follicle (1 of 8) and from none of the mature egg follicles (0 of 8). In the second trial, *C. perfringens* was detected in 11 of 12 ceca, and from none of the immature or mature yolk follicles. At this stage, based on the low follicular-derived isolation rate of *C. perfringens*, observed in this limited sized study, it appears that the ovary section of the reproductive tract is not a particularly major source of *C. perfringens*. However, this evidence does not exclude the potential for the other segments of the hens reproductive tract nor the contribution of rooster semen as a harborage or source of *C. perfringens*. For the extent of the reproductive tract as a reservoir for *C. perfringens* to be more fully understood, trials during overt instances of necrotic enteritis and from drug-free facilities will be performed over different seasons. The genotypic comparison of the cecal-immature follicle paired isolates of *C. perfringens* is ongoing.

Key Words: *Clostridium Perfringens*, Broiler Breeder Hens, Yolk Follicles

M295 Response of broilers to graded levels of sodium chlorite and citric acid in water. P. Mohyla*¹, S. F. Bilgili¹, C. C. Warf², and G. K. Kemp², ¹Auburn University, Auburn, AL, ²Alcide Corporation, Redmond, WA.

Acidified sodium chlorite (ASC; SANOVA) is a highly effective sanitizer, currently approved for product-contact use in poultry processing. ASC is formed by combining sodium chlorite (SC) and citric acid (CA). The

in vivo efficacy of ASC against foodborne pathogens has not been assessed. This study was conducted to evaluate the tolerance of birds to graded levels of SC and CA administered in the drinking water. A total of 320 broilers, at 35 days of age, were randomly allocated to 64 pens (5 birds/pen). Water treatments consisted of 8 concentrations of SC (0, 0.012, 0.03, 0.06, 0.12, 0.3, 0.6 and 1.2%) and 8 concentrations of CA (0, 0.003, 0.01, 0.02, 0.04, 0.08, 0.18 and 0.4%). All solutions were prepared and replaced twice a day. Water intake, feed consumption, weight gain, and mortality were monitored during the seven day experimental period. No significant ($P>0.05$) differences were detected in mortality during the experiment. CA levels of up to 0.4% did not affect live performance. Whereas, SC concentrations above 0.12% significantly lowered weight gain and feed consumption. Linear and quadratic response to daily and 7-day water consumption was observed for graded levels of CA and SC in the water. Overall, concentrations of up to 0.02% of CA stimulated water consumption and may actually have a positive effect on feed efficiency ($P<0.05$). SC concentrations beyond 0.06% negatively affected live performance and water intake ($P<0.05$).

Key Words: Citric Acid, Sodium Chlorite, Performance of Broiler

M296 Effect of high flow rate nipple drinkers on the performance of 21 d old male broiler chicks. W. B. Roush^{*1}, B. D. Lott², and S. L. Branton¹, ¹USDA-ARS Poultry Research Unit, Mississippi State, MS, ²Poultry Science Department, Mississippi State, Mississippi State.

Two trials were conducted to examine three week production effects of providing water to broiler chicks with bell and two nipple drinker treatments with low (week1: 30ml/min; week 2: 40ml/min and week 3: 50ml/min or continuous high (120 ml/min) flow rates. In each trial, 80 male chicks were placed on litter in each of nine environmental chambers. Each treatment was replicated in three environmental chambers. Temperature was 32 degrees C for the first week and reduced by 2.6 degrees C weekly. Starter diets, provided as crumbles, and water were provided for ad libitum consumption. Light was continuous. Water consumption was recorded at 6 hour intervals. Bird weights, feed consumption and litter moisture for each chamber were determined weekly. Litter samples for moisture determination were collected in a 1 foot radius of the drinkers. Statistical significance was considered at $P = 0.05$. There were no significant differences in the weight gain for the first two weeks. At week 3 the weight gains for broilers on the bell drinker were significantly larger (469 g) than the birds on low (455.7g) or high flow (451.0g) drinker treatments. Feed conversion during the first week was significantly improved for birds drinking from high flow drinkers; however, there were no differences in feed conversion for the second or third weeks. There was no difference for water usage between bell (121.1 ml/bird) and high flow (121.5 ml/bird) drinkers with a significantly lower usage (109.4 ml/bird) for low flow drinkers. There were no treatment differences in litter moisture or percent livability.

Key Words: Broiler, Nipple Drinkers, Bell Drinkers

M297 Turkey strain effects on commercial turkey tom and hen performance. J. L. Grimes^{*1}, A. N. Crouch², P. R. Ferket¹, A. G. Gernat¹, J. L. Godwin¹, and R. Neely¹, ¹Dept. of Poultry Science, N. C. State University, College of Agriculture & Life Sciences, Raleigh, Dept of Poultry Science, Raleigh, NC, ²B.U.T.A, Lewisburg, WV.

The effect of strain on turkey performance was examined. Birds of four strains (males and females) from two primary breeders (B3,B2,N88,N85) were reared in a curtain-sided house with 96 pens (6.2 sq m per pen). Fifty tom or 66 hen poults were placed, on day of hatch, in each of 48 pens on one end the house in a randomized complete block design to provide 6 pens per strain and sex for a total of 1200 toms (300 per strain) and 1600 hens (400 per strain). There were 4 rows of pens with 12 pens per row. One row of pens served as a block. Two blocks were used for toms and two for hens. At five weeks of age, each pen of birds was evenly split. One half remained in the original pen while the other half was placed into a pen at the other end of the building. The same experimental design was used on both ends of the building. Feed was provided by a commercial mill. Feed consumption (by pen) and mortality were monitored. Feed conversion ratios (FC) were calculated. Birds were weighed at 5, 10, and 15 wk. Toms were weighed and processed in a commercial processing plant at 144 d while the hens were weighed and processed at 147 d. Carcass yield was determined for P. major, P. minor

& total breast meat for four pens of toms and three pens of hens per strain. The pen was the experimental unit and data were analyzed by regression ($P<0.05$). At market age, B3 toms were heavier than B2 while both were heavier than N88 or N85 (22.1^a, 21.5^b, 20.6^c, and 20.1^c kg, sem=0.20). At 15 wk, B3 hens were significantly heavier than B2, N88 or N85 hens (9.4^a, 9.0^b, 9.0^b, and 8.9^b kg, sem=0.07) At market age, B3 hens were the heaviest followed by B2, N88, and N85 (14.2^a, 13.6^b, 13.2^{bc}, and 13.1^c kg, sem=0.13). Neither Toms (FC=2.60, sem=0.04) nor hens (FC=2.64, sem=0.05) differed in FC at market age. B3 (5.8 kg) and B2 (5.7 kg) toms produced more breast meat than N88 (5.2 kg) or N85 (5.3 kg) toms but had increased relative breast meat yield only when compared to N88 toms. B3 (3.7 kg) and B2 (3.65 kg) hens produced more breast meat than N88 (3.4 kg) or N85 (3.4 kg) hens but only B3 hens had a greater relative breast meat yield. In conclusion, tom and hen turkeys performed differently due to strain under the conditions of this study.

Key Words: Turkey, Performance, Strains

M298 The effect of vitamin C supplementation to breeder hens and light during incubation on embryonic development and hatchability. T. El-Sheikh^{*1}, N. Makled², and A. El-Gammal², ¹Faculty of Agriculture, South Valley University, Sohag, Egypt, ²Faculty of Agriculture, Assuit University, Assuit, Egypt.

A total number of 500 Dandarawi laying hens were divided randomly into two groups of 250 each, the first was fed basal diet supplemented with 200 grams of vitamin C per ton, while the second was kept as a control. A total of 4200 hatched eggs representing vitamin C supplemented and unsupplemented groups. The eggs from each group were classified into seven treatments as follows: 1- The eggs were subjected after setting to 24 L:0D for 18 days and then darkness during the last three days. 2-The eggs were subjected to 24 L:0D for 12 days of incubation period. 3- The eggs were subjected to 24 L:0D for 6 days. 4-The eggs were subjected to 0L:24 D during all incubation period. 5-The eggs were subjected to 12L:12D for 18 days. 6-The eggs were subjected to 12L:12D for 12 days of incubation. 7-The eggs were subjected to 12L:12D for 6 days of incubation. The relative embryo weight to initial egg weight, chemical composition of embryos, hatchability, embryonic viability and incubation period were measured. Embryos from eggs subjected to different systems of illuminations were heavier than those from eggs which were unilluminated. The eggs incubated under 24L:0D had heavier embryos than those incubated in 0L:24D, while those incubated under 12L:12D had intermediate weights. The moisture content decreased by age of the embryo and increased by vitamin C supplementation. Also, it decreased by the increase in photoperiod and by the time of exposure. Protein content decreased by age in all treatments and increased by vitamin C addition. Also, it increased by the increase in photoperiod and time of exposure. Fat content increased as the age of embryo increased. Vitamin C addition led to significantly increase in the fat content at all ages. Continuous light caused an increase in embryonic mortality than those of 12L:12D and 0L:24D lighting program. The overall percentage of dead embryos (based on fertile eggs) was 3.23, 2.9 and 1.9 % for 24L:0D, 12L:12D and 0L:24D, respectively. Total embryonic mortality increased as the time of light exposure increased. Eggs incubated in 24L:0D had lower hatchability than that of their control and 12L:12D.

Key Words: Dandarawi Embryo Development, Incubation Light, Vitamin C

M299 Evaluation of different means of feeding corticosterone to broilers to elicit a stress response. W. S. Virden^{*1}, C. D. Zumwalt¹, J. P. Thaxton¹, S. L. Branton², and M. T. Kidd¹, ¹Mississippi State University, Mississippi State, ²United States Department of Agriculture.

Glucocorticoid hormones such as corticosterone (CS) are necessary to facilitate the catabolism of protein and fat to produce glucose for energy during stress. If excessive levels of blood CS are maintained, detrimental effects on growth can occur due to excessive turnover of body tissue for gluconeogenesis. Two experiments (Exp) were conducted to determine the effects of feeding CS on broiler performance using two methods at different ages. In Exp 1, Ross 308 male chicks were placed in floor pens and received either a control diet, or a diet containing 5 mg/kg of CS suspended in soybean oil (2 treatments, 24 replications) during the prestarter period (d 1 to 7). From d 8 to 21, chicks received common starter diets containing no CS. A factorial array of diet (high or low

nutrient density (ND) fed from d 1 to 42) and CS (0 or 20 mg/kg of diet in ethanol administered from d 18 to 21) was used to evaluate performance of Ross 308 chicks in Exp 2. In Exp 1, chicks receiving CS had decreased ($P < 0.05$) BW gain, feed intake, and livability from d 0 to 21. In Exp 2, CS and ND interacted ($P < 0.05$) to affect feed intake from d 0 to 34, as broilers fed diets containing high ND and CS had higher feed intake than broilers fed low ND and CS. From d 0 to 21 and d 0 to 42 feed intake was decreased ($P < 0.05$) in broilers fed CS. Dietary ND improved ($P < 0.05$) BW gain in all periods, but only overall feed conversion. Dietary CS decreased and increased ($P < 0.05$) BW gain and feed conversion, respectively, from 0 to 21, 0 to 34, and 0 to 42 d. Subsequent experimentation is underway to evaluate blood profiles and chemistry of broilers to correlate findings to the results presented herein.

Key Words: Broiler, Corticosterone, Stress

M300 The impact of egg weight on hatchability, chick weight, chick length, and chick weight to length ratios. J. J. Lawrence*, A. D. Gehring, A. D. Kanderka, G. M. Fasenko, and F. E. Robinson, *Department of AFNS, University of Alberta, Edmonton, Alberta, Canada.*

The objective of this study was to examine the effects of egg weight on hatchability, and hatched chick and two week old broiler growth parameters. Broiler hatching eggs ($n=900$) were obtained from a 43 wk old Cobb 500 FF commercial flock. Eggs ($n=300$) from three weight ranges (Small (S):6063g; Average (A):6065g; Large (L):70-73g) were incubated then candled at 7 and 14 days to remove and break open any eggs with non-viable embryos. Eggs remaining at 18d were weighed and transferred into pedigree hatch baskets. At 21.5d all saleable chicks were neck tagged, weighed, and chick length measured. Eleven groups of 20 chicks for each egg weight range were randomly allocated to one of 33 cages and provided with feed and water ad libitum. At 14 d of age the birds were weighed and body and shank length measured. The data were analyzed using the GLM procedure of SAS[®] and probability assessed at $P \leq 0.05$. Egg, chick, and two week broiler weights were significantly different between the egg weight groups (Segg=61.8±0.1g; Aegg=66.5±0.1g; Legg=71.3±0.1g; Schick=43.0±0.1g; Achick=46.4±0.1g; Lchick=49.9±0.1g; S2week=264±0.7g; A2week=281±0.7g; L2week=296±0.7g). Hatchability of fertile eggs was lowest in the L (81.8±2.0%) compared to the S (92.4±2.0%) and A groups (89.4±2.0%) which did not differ from one another. This was due to a higher incidence of culled chicks from the L (12.2±1.6%) versus the A (5.1±1.6%) or S (2.8±1.6%) groups, which did not differ from each other. Chick and two week broiler lengths (Schick=185±0.3mm; Achick=188±0.3mm; Lchick=191±0.3mm; S2week=311±0.7mm; A2week=316±0.7mm; L2week=326±0.7mm) and weight to length ratios (Schick=0.233±0.001; Achick=0.247±0.001; Lchick=0.261±0.001; S2week=0.848±0.001; A2week=0.888±0.001; L2week=0.907±0.001) were also significantly different between all three egg weight groups. These data support previous research showing that chick weight is dependent upon egg weight at setting, and also provide new data on the relationship between egg weight and chick length.

Key Words: Egg Weight, Hatchability, Chick Weight to Length Ratios

M301 Detection of early changes in fertile eggs during incubation using a hyperspectral imaging system. D. P. Smith*¹, J. M. Mauldin², K. C. Lawrence¹, B. Park¹, and G. W. Heitschmidt³, ¹USDA, ARS, Russell Research Center, Athens, GA, ²Department of Poultry Science, University of Georgia, Athens, ³Biological and Agricultural Engineering, University of Georgia, Athens.

Detection of fertility prior to incubation or the recognition of development during the first 3 days of incubation could benefit hatcheries, as they could remove infertile or non-developing eggs before investing significantly in incubator space and utilities, or risking contamination from "exploding" eggs. This study was conducted to determine the feasibility of using a hyperspectral imaging system (CCD detector, spectrograph, lens assembly, and software) to detect changes in incubated eggs related to fertility and development. For each of two replicate trials, 48 unincubated SCWL eggs were obtained from a commercial hatchery, incubated, and then 12 eggs were removed and imaged on each of days 0, 1, 2, and 3 ($n=96$). Hypercube images were collected on each egg (wavelengths from approximately 400 to 900 nm) using tungsten-halogen backlighting

with a 30 millisecond exposure time. Eggs were then broken out for confirmation. A ratio of transmittance images at two different wavelengths, (found to optimize detection of blood in eggs during a preliminary experiment) was used to detect blood ring formation. On day 3, 23 of 24 eggs were determined fertile by breakout; the hyperspectral imaging system accurately classified the one infertile egg and 22 of the 23 fertile eggs. The blood ring was not detected on days 0 or 1, and not consistently on day 2. Insufficient light transmission for one fertile egg prevented its classification. The hyperspectral imaging system appears capable of detecting fertile egg development based on blood ring formation on day 3 of incubation.

Key Words: Egg Fertility, Embryo Development, Hyperspectral Imaging

M302 Broiler litter sampling procedures. A. S. Tasistro, C. W. Ritz*, and D. E. Kissel, *University of Georgia, Athens.*

Sampling procedures are critical in broiler litter analysis for appropriate nutrient management planning efforts and to minimize the spatial variability of nutrient concentrations influenced by conditions such as litter moisture content and waste feed. There is a need for practical alternatives that help obtain representative samples and that simultaneously allow enough time to receive and apply the analytical results. Litter from a commercial broiler house was sampled in two ways: 1) Thirty samples were taken based on a grid that incorporated sampling points around the feeders, waterers, and center of the house), and 2) Five samples were taken from trenches dug from the center of the house to the sidewall. The number of sub-samples needed to have mean estimates for each elemental litter component within specified limits of statistical accuracy were estimated using conventional statistical procedures and computer intensive random resampling procedures. The mixing of litter material associated with trench sampling reduced the variability in the concentrations of all elements analyzed, and resulted in a reduction in the number of sub-samples needed to attain comparable levels of statistical accuracy. Specific for nitrogen (N), the Coefficient of Variation of N concentrations in samples from the grid and trenches were 17 and 6 %, respectively. The number of sub-samples needed to estimate the mean N concentration within 15% of the experimental mean 95% of the time when sampling by taking individual floor samples and digging trenches were 6 and 2, respectively.

Key Words: Broiler Litter, Sampling, Composition

M303 Effects of organic acid on control of bacteria growth in drinking water for broilers. G. M. Pesti*¹, R. I. Bakalli¹, P. F. Vendrell², and H.-Y. Chen³, ¹Department of Poultry Science, University of Georgia, Athens, ²Agricultural and Environmental Services Laboratories, University of Georgia, Athens, ³Kemira Oyj Helsinki, Finland.

A total of 664 male Cobb birds were used to evaluate the effect of an organic acid product AMMFOR-pH on the control of microbial growth in drinking water. AMMFOR-pH is a formic acid based product, which is partially ammoniated for improving handling characteristics. One-day-old birds with an average body weight of 40 g were randomly assigned to one of four pens. There were two water treatments, control and experimental (with added AMMFOR-pH at 0.01%). Birds in both treatments were fed the same commercial broiler diets. There were 12 bell drinkers in total, three bell drinkers per pen. Water consumption and pH and bird mortality in each pen were recorded daily. Water samples were taken from all drinkers three times a week for five weeks, and were analyzed for pH, *E. coli* and total enterococcus counts. All birds were weighed on days 0 (43 vs. 43 g), 18 (715 vs. 707 g), and 35 (2117 vs. 2146 g for control and AMMFOR-pH treated birds, respectively). Feed consumption was measured on days 18 (928 vs. 932 g) and 35 (3301 vs. 3310g) and feed conversion ratios (FCR) were calculated. From 0 to 18 days and from 0 to 35 days FCR (1.380 vs. 1.405, and 1.592 vs. 1.574 kg feed/kg gain) were very similar. In the AMMFOR-pH treated group, water pH rose from 3.68 to 5.45 after 24 hours, compared to an average of 7.06 in the control group. The changes in water pH resulted from contaminations of feed and litter materials. Water consumption and bird mortality were not significantly different between the control and AMMFOR-pH treated groups. *E. coli* and total enterococcus were reduced by 49% and 56%, respectively, in drinking water treated with AMMFOR-pH, compared with the control. The results of this study suggest that incorporation of AMMFOR-pH in drinking water for broilers improves the hygienic quality of drinking water by inhibiting the

growth of bacteria, and may reduce contamination of bacteria in broiler chickens.

Key Words: AMMFOR-pH, Broiler, Drinking Water

PSA-Extension/Instruction

M304 Development of a quality control laboratory design project for poultry science undergraduate students enrolled in an advanced food microbiology course. R. S. Hardin*, M. M. Kunder, C. L. Woodward, L. M. Donalson, J. L. Golbach, and S. C. Rieke, *Department of Poultry Science, Texas A&M University, College Station.*

With the ever-increasing demand for problem solving skills in today's poultry workforce, more emphasis is needed on integrated training at the undergraduate level. An exercise for designing a quality control laboratory was developed as a laboratory group project in a senior level undergraduate advanced food microbiology course taught in the poultry science department at Texas A&M University. The assignment was based on the students designing their own laboratory and implementing testing methods for different types of bacteria known to cause food-borne illness. They were responsible for determining what equipment was needed for their specific pathogen as well as general supplies and materials required for setting up a fully equipped laboratory. Individual research papers were required of each student midway through the semester to gain a sufficient background on the pathogen; including discussion of the importance, detection methods, and the prevention and control of the pathogen assigned to their group. In each of the laboratory sections students were separated into groups of four students who were then responsible for a group project report. At the end of the semester the group report was required to include a lab diagram indicating where equipment would be placed as well as a comprehensive budget including a list of prices needed to set up the laboratory designed by the group. The group project report was also required to contain justification for specific equipment and materials requested, based on the pathogen and scenario given to the groups discussed where samples would be taken from, how often samples would be taken, as well as what isolation methods would be used. Students were also required to develop waste management procedures to handle all possible biohazard materials. Successful completion of the project provided students with problem solving skills essential for the poultry industry.

Key Words: Food Microbiology, Review Paper, Quality Control Laboratory Design

M305 Student understanding of molecular genetics concepts. B. S. Walters* and T. J. Buttles, *University of Wisconsin, River Falls.*

The purpose of this study was to increase student understanding of molecular genetics concepts. Current students in colleges of agriculture will be entering a world shaped by biotechnology. Applications of biotechnology such as genetically modified crops have been adopted at a rate greater than any other technology in the history of agriculture. Animal applications of biotechnology are also on the rise and raise additional ethical questions. DNA transcription, RNA translation, and protein structure development all play a key role in modern applications of biotechnology. An understanding of these processes lays the foundation for understanding the bigger picture of biotechnology applications in agriculture. The goals of this Scholarship of Teaching and Learning project were to first identify students' background knowledge and then

to evaluate the effectiveness of different instructional approaches in increasing student understanding. The starting point for the project was to determine the level of understanding students brought to the course. Students were given the opportunity to complete a short questionnaire asking for related course information (completed or in-progress: Introductory Biology, Animal/Plant Genetics, Animal/Plant Breeding, Introduction to Biotechnology) and definitions of 5 terms (messenger RNA, transfer RNA, ribosomal RNA, transcription, translation). Nearly all students had completed Introductory Biology and at least one additional course that included molecular biology concepts. Despite this background, few students could correctly define all 5 terms. Based on these findings, classroom activities were developed where students examined the core molecular genetics concepts from a variety of perspectives.

Key Words: Undergraduate Education, Teaching, Biotechnology

M306 What does the poultry industry want when recruiting undergraduates? - an ongoing perspective survey to evaluate the importance of certain employable skills to the poultry industry. K. M. Downs*¹, J. E. Mehlhorn², J. B. Hess³, and J. L. Wilson⁴, ¹Middle Tennessee State University, Murfreesboro, ²The University of Tennessee at Martin, Martin, ³Auburn University, Auburn, AL, ⁴The University of Georgia, Athens.

A survey instrument was developed to assess personality traits and competency levels important to poultry managers for achieving success in the poultry industry. Twenty questions seek to evaluate the importance of personality characteristics and subject matter competencies sought in new employees. Remaining questions evaluate the importance of seven common industry recruitment efforts. A Likert scale (1=unimportant to 5=critically important) is used to quantify responses, and managers in all phases of broiler and table egg production are targeted. Surveys are mailed with an explicative cover letter, self-addressed stamped envelope, and appreciation gift. At present, personnel in TN, AL, and GA have been targeted; however, to strengthen statistical inferences, administration will continue.

Response rate is currently 52.3%. Most managers completing the survey classified themselves as working in the processing (36%), live production (23%), or HR (19%) sector. To date, respondents (n=23) indicate the five most important characteristics for employment success are integrity (4.87), teamwork (4.83), adaptability (4.39), problem-solving (4.39), and oral communication (4.39). Conversely, the five least important parameters were undergraduate major (2.74); knowledge of foreign language (2.83), basic science (2.83), or computer hardware (2.87); and previous work experience (2.91). Respondents evaluated the most effective recruitment tools to be departmental career fairs (3.64) and informal university contacts (3.64). Trade publications (2.48) and on-line job sites (2.40) were considered the least beneficial for recruitment.

Developing aptitude in team building, problem-solving, and oral communication should be priorities in undergraduate education. Furthermore, fostering strong industry ties should be a significant objective of those in academia to more effectively place students in the poultry industry. This collaborative work is ongoing.

Key Words: Undergraduate Education, Recruitment, Poultry Industry

Milk Protein and Enzymes: Dairy Foods

M307 Exploring the structure and dynamics of labeled β -lactoglobulin using high field NMR spectroscopy. P. J. B. Edwards¹, G. B. Jameson¹, G. E. Norris², T. S. Loo², K. A. N. S. Ariyaratne¹, D. Uhrin³, P. N. Barlow³, and L. K. Creamer*⁴, ¹Institute of Fundamental Sciences, ²Institute of Molecular Biosciences, ³Edinburgh Protein Interaction Centre, ⁴Fonterra Research Centre.

Bovine β -lactoglobulin (BLG) is the major whey protein and dominates the effects of heat and pressure on the structure and disulfide bonding of this protein. The two common genetic variants, BLG A and BLG

B, behave quite differently in their reactions. For example, BLG A is more readily hydrolyzed and easier to heat denature than BLG B. The X-ray crystal structures do not show any features that could explain this behavior and consequently an extensive project was initiated to resolve this question. A polynucleotide was synthesized and expressed to give fusion proteins, corresponding to both the A and B variants. These were subsequently cleaved to obtain synthetic BLG A and BLG B. Addition of ¹⁵N and/or ¹³C nutrients to the growth media allowed labelled proteins to be made and these have been used to confirm the previously

published assignments for the A variant and to assign residues close to the substitution sites in the B variant. Using this base information the accessibility of each of the amide N atoms was determined as a function of temperature using H/D exchange. Preliminary results of a ^{15}N NMR relaxation study indicate some small differences in the backbone dynamics of BLG A and BLG B. The significance of these results will be discussed in terms of the different stabilities of BLG A and BLG B.

Key Words: Molecular Dynamics, Labeled Lactoglobulin, Temperature Effects

M308 Water distribution in cheese and cheese models: Application of NMR techniques, including the inverse 2D-LaPlace transform. A. Gottwald¹, P. L. Hubbard¹, P. T. Callaghan¹, P. J. Watkinson², and L. K. Creamer^{*2, 1} *School of Chemical and Physical Sciences, Victoria University of Wellington, New Zealand, ²Fonterra Research Centre, Palmerston North, New Zealand.*

Most cheese is a complex dispersion of protein (casein), butterfat, and their degradation products, in water containing some mineral material. Using a 7 T NMR spectrometer (300MHz for ^1H) ^1H signals of water and oil can be resolved by chemical shift differences. The protein signals are usually overwhelmed by these two major signals because of the differences in relaxation time. NMR-relaxation (T_2) and NMR-diffusion (D) were determined for the water and were then transformed to give two-dimensional (2D) plots of D vs T_2 . There were a number of spots on the 2D plot and this indicated that there were several water environments. A similar plot was obtained from the butterfat signal. For a better understanding of the origin of different relaxation rates and/or diffusion coefficients, cheese models with a simpler composition were prepared and studied under similar conditions as the cheese. The simplest model was sodium caseinate dissolved in water at neutral pH. The simplest butterfat model was liquid paraffin oil, in which all protons are bonded to carbon, which was emulsified into the caseinate solution. Further complexity was introduced by replacing some of the sodium ions with calcium. This changed the concentrated caseinate solution with emulsified oil into a semi-solid visco-elastic material. Diffusion coefficient D and relaxation time T_2 of the water protons in the models are similar to the values in real cheese. Both values (D and T_2) decrease if the protein content in the model system is increased. The NMR behavior of the oil, which exists in discrete droplets, is unaffected by protein concentration.

On the other hand, there are some significant differences between natural cheese and these model systems which clarifies our understanding of the natural cheese system.

Key Words: Cheese Water Mobility, Caseinate Solution, Model Cheese System

M309 Effects of genetic modification, pressure, and heat on the binding of various probes to β -lactoglobulin. H. A. Patel^{1,2}, T. Considine^{1,3}, S. G. Anema^{3,2}, H. Singh³, and L. K. Creamer^{*1}, ¹Fonterra Research Centre, Palmerston North, New Zealand, ²Institute of Nutrition, Food and Human Health, Massey University, Palmerston North, New Zealand, ³Riddet Centre, Massey University, Palmerston North, New Zealand.

Native β -lactoglobulin (BLG) has been shown to bind a number of hydrophobic and amphipathic molecules within the central calyx. Examples are: hexane, retinol (vitamin A), cholesterol, 12 bromo-dodecanoic acid, palmitic acid, and cis-parinaric acid (CPA) but not anilino-naphthalene sulfonate (ANS). The binding of retinol and CPA can be followed by induced circular dichroism or increased fluorescence. This has allowed the determination of the displacement of CPA or retinol by dodecyl sulfate (SDS) or palmitate, but not by ANS. Heat treatment denatures the BLG, and the binding of CPA and retinol decreases in proportion with the extent of denaturation while ANS fluorescence increases. Pressure treatment has a similar effect. Addition of these ligands of BLG increases the stability of the protein under increased temperature and pressure. ANS does not have this effect. Polynucleotides were synthesized and expressed to give fusion proteins, corresponding to both the A and B variants of BLG. These were subsequently cleaved to obtain synthetic BLG A and BLG B. Modification of the polynucleotide allowed the preparation of a number of different BLG mutants. Some of these were modifications close to the binding site of retinol and the fatty acids. In particular the change of lysine to glutamic acid at residues 60 and 69 showed dramatic differences in behavior. These two residues are close spatially but the change at residue 60 prevents binding of retinol or CPA while that at residue 69 does not.

Key Words: Whey Protein Concentrate, Heat Treatment, Pressure Treatment

ABSTRACTS
Monday, July 26, 2004

SYMPOSIA AND ORAL SESSIONS

* Author Presenting Paper

**PSA Ancillary Scientists Symposia: Agricultural Biosecurity:
Emerging Issues in Homeland Security & Food Safety**

1 Antibiotic use in Animals and the Impact of the Growth Promoter Ban in Europe. R. B. Phillips*, *Animal Health Institute, Washington, DC.*

Antibiotic use in food animals in the United States is trending down as producers become more careful and efficient in their use of antibiotics. Surveillance data and recent quantitative risk assessments suggest the human health risk from resistance food borne pathogens is quite small. Conversely, risk assessments and the European experience suggest the benefits of antibiotics used in food animals have been underappreciated. A non-science driven ban on growth promoter use in Europe resulted in increased bacterial illnesses in animals while producing no human health benefits. Taken together, these bodies of evidence suggest that policy actions not based on science will have negative unintended consequences. The best public health measures will include a combination of increased surveillance, continued improvements in food hygiene and rational, judicious use of antibiotics in food animals.

Key Words: Antibiotics, Risk Assessment, Resistance

2 Enzymatic degradation of prions and prevention of transmissible spongiform encephalopathies. J. Shih*, *Department of Poultry Science, North Carolina State University.*

Infectious prion protein (PrPres) is believed to be the causative agent of bovine spongiform encephalopathy (BSE) or mad cow disease, sheep scrapie elk chronic waste disease (CWD) and human Creusfeldt-Jakob disease (CJD). The protein is recalcitrant and resistant to common proteases and heat sterilization. A feather-degrading keratinase, was found to be able to degrade PrPres in the brain tissues of BSE cows and scrapie sheep. After homogenization, pre-heating at 115 oC, and the keratinase digestion, PrPres was completely degraded to an undetectable level by Western blott. Biological tests in transgenic mice are in progress to confirm the dis-infection of the tissue born PrPres by the enzyme. In order to study the degradation mechanism and to improve the effectiveness of the enzyme, a non-pathogenic surrogate protein system was

developed in this laboratory. Sup35NM, a prion-like protein from yeast, was produced and analyzed for its characteristic folding, aggregation, and degradation by proteinase K and keratinase. With the keratinase and the surrogate protein, this laboratory is equipped to develop a new process for enzymatic inactivation of PrPres in the decontamination of equipment and the rendering process for prion-free animal products. This new method and other existing dis-infection methods will be reviewed in the presentation. (Supported by USDA, FDA and National Cattlemen's Beef Association)

Key Words: Prion Protein, Keratinase

3 Mycotoxin detoxification and microorganisms in feeds. G. Schatzmayr*¹, D. Schatzmayr*¹, M. Täubel¹, S. Nitsch¹, A. P. Loibner², and E. M. Binder³, ¹*Biomim IAN GmbH, Industriest. 21, 3130 Herzogenburg, Austria*, ²*IFA-Tulln, Department of Environmental Biotechnology, Konrad Lorenzstrasse, 3430 Tulln, Austria*, ³*Erber AG, Industriestrasse 21, 3130 Herzogenburg, Austria.*

Mycotoxins are secondary metabolites of fungi affecting human and animal health. Mycotoxins of major concern for poultry are especially aflatoxins, trichothecenes and ochratoxins. In poultry aflatoxins cause for instance haemorrhages, nervous syndrome and pale bird syndrome whereas certain trichothecenes lead to feed refusal, haemorrhages and oral as well as dermal lesions. Ochratoxin A is responsible for damages of kidneys and liver. All of the above mentioned mycotoxins suppress the immune system of birds at relatively low concentrations. In spite of all efforts to prevent the formation of mycotoxins in the field and during storage high contaminations still occur. To alleviate negative effects on animals detoxification strategies are needed. Clay minerals have been used in the feed industry to bind aflatoxins, but it turned out that these binders are very specific for aflatoxins but not for the other toxins which show a great variation in their chemical structures. A novel strategy to control the problem of mycotoxicoses in poultry is the application of microorganisms capable of biotransforming mycotoxins into non-toxic

metabolites. A new strain belonging to the genus of Eubacterium isolated out of rumen fluid of cattle is able to deactivate trichothecenes by reduction of the epoxide ring. This mode of action was proven in vitro and also in vivo by applying trichothecenes and the detoxifying strain Eubacterium BBSH 797 to chicken. In a very recent project a novel yeast strain, capable of degrading ochratoxin A and zearalenone was isolated and characterised. Due to its affiliation to the genus of Trichosporon and to its main property to degrade mycotoxins this strain was named Trichosporon mycotoxinivorans. This strain showed detoxification in vitro and in vivo. Together with clay minerals Eubacterium BBSH 797 and Trichosporon mycotoxinivorans can be used in a formulation to prevent poultry from mycotoxicoses caused by aflatoxins, trichothecenes and ochratoxins.

Key Words: Mycotoxins, Deactivation Strategies, Microorganisms

4 Withdrawn by author. , .

5 Avian Influenza, Vaccines and Control. D. Swayne*, *US Department of Agriculture, Agricultural Research Service, Southeast Poultry Research Laboratory, Athens, GA.*

Avian influenza (AI) is a viral disease of birds caused by type A orthomyxoviruses. Avian influenza viruses are further classified into 15 different hemagglutinin (H1-15) and 9 different neuraminidase (N1-9) subtypes. Biologically, AI viruses can be of low (LP) or high pathogenicity (HP) for chickens and related poultry species. Dealing with AI

has focused on one of three goals: prevention, management (control) or eradication. In most developed countries, LP AI and HPAI are not common in commercial poultry and thus prevention is the primary goal. However, if AI occurs, eradication is the overall goal with epizootics of HPAI being eradicated through a strategy that includes enhanced biosecurity, surveillance or diagnostics to identify infected farms, quarantine of infected premises, depopulation and disposal of infected poultry, and cleaning and disinfection of infected premises. Vaccines have been used to manage economic losses from LP AI or, in some instances, have been used as a tool in LP AI or HPAI eradication strategies. AI vaccines can prevent clinical signs and death in poultry, increase resistance of birds to infection, and decrease the amount of virus shed in the environment. However, vaccines alone will not eradicate AI. High pathogenicity AI impacts international trade as does some forms of LP AI. Experimental studies in chickens have shown that LP AI viruses cause respiratory and gastrointestinal infections without infecting the meat. By contrast, HPAI viruses produce infection of respiratory and gastrointestinal tracts, produce a viremia and virus is present in the meat and internal contents of eggs during the acute stages of the infection. Additional experimental studies have demonstrated that pasteurization of liquid egg products using USDA guidelines will inactivate HPAI virus that have been artificially added to levels in excess of those reported in eggs laid by HPAI virus-infected hens. Although, no virus has been demonstrated in internal contents of eggs laid by LP AI virus infected hens, pasteurization has been shown to inactivate LP AI virus artificially added to egg products.

Key Words: Avian Influenza, Vaccine, Trade

Combined Animal, Dairy and Poultry Extension Workshop

6 Washington update. R. Reynnells, *National Program Leader, Animal Production Systems, USDA-CSREES.*

The 2004 Annual Extension Special Recognition Award is presented to Dr. Mike Hulet, (PA), who has made many significant leadership contributions in the areas of environmental protection and animal well-being. Muquarrab Qureshi joined us as National Program Leader (NPL) for Animal Genetics. Our NPL position for Veterinary Medicine continues to be available. I want to encourage you to participate in multi-state research committees, which will increase in importance with our ever-reducing number of poultry faculty. WCC-204, Animal Bioethics, is an important committee that complements other activities at Land Grant Universities. The Southern Region Poultry Extension Workshop (Triennial) committee is more national in character and continues discussions of scheduling changes. John Carey (TX) is Chair, and Ken Anderson, Vice Chair of that committee and they request you provide comments and volunteer. The 2004 National Poultry Waste Management Symposium is in Memphis, and is coordinated by Mike Hulet (PA); with Susan Watkins (AR) Coordinator for 2006. The Future Trends in Animal Agriculture held a program in 2002 (Standards), two in 2003 (Science and Ethics; and, Costs of Changes), with another scheduled for 2004 (Local and Global Considerations) to create opportunities for positive dialogue between industry and activists. Proceedings are available. The National Poultry Infobase will be terminated in 2004. A national Regionalization Workshop prioritized mechanisms to implement effective programs. Proceedings are available.

Key Words: Recognition Award, Animal Well-Being, Triennial Workshop

7 Confined Animal Feeding Operation (CAFO) regulations impact and record keeping requirements for livestock operations. G. E. Erickson*, R. Koelsch, C. Shapiro, and C. Wortmann, *University of Nebraska, Lincoln.*

In 2002, USEPA revised regulations for confined animal feeding operations (CAFO) to appropriately update federal requirements in the 1972 Clean Water Act, and specifically the National Pollutant Discharge Elimination System (NPDES). The goal of the revised regulations is to ensure clean surface water in the US. The revisions address runoff control, manure storage, nutrient utilization, and record-keeping and related livestock water quality issues. CAFO is defined by facility, risk of nutrients entering water, and size. Large CAFOs have at least 1000 cattle, 700 dairy, 2500 finishing swine, or 125,000 broilers. Smaller operations can be designated as a CAFO under some circumstances. By December 31, 2006, nutrient management plans (NMP)

and record keeping are required for CAFOs. The USEPA requirements are the minimum requirements to which individual States must respond. State requirements may be more demanding and comprehensive than the minimum established by USEPA. Comprehensive Nutrient Management Plans (CNMP) are defined by USDA to monitor nutrient flow, minimize excretion, appropriately utilize nutrients, and keep records. CNMPs are more comprehensive than NMP and address feed management and alternative uses or technologies for managing manure. NMP records that must be maintained for five years include: the annual NMP, analysis of manure and soils receiving application, crop nutrient requirements, the basis for determining the rate of application, dates and methods of application, amounts of N and P applied, and a cropping season summary. The USEPA regulations require that CAFOs submit an annual report. USEPA is allowing the States to determine the threshold at which manure application rates can no longer be based on crop N need or removal and P-based application are required. This threshold is affected by several that define the potential for runoff P loss from individual fields. Considerable education efforts are underway nationally, regionally, and through land-grant institutions.

Key Words: Nutrient Management, Regulations, Animal Feeding Operations

8 Waste management alternatives: composting, methane production and other options. L. E. Carr, *University of Maryland, College Park.*

This presentation will address waste management alternatives to include: composting manures and normal mortalities from animal and poultry production systems; methane production from various manures and potential utilization of the end products; processing poultry and turkey litter for organic fertilizer and value added fertility products; and direct combustion. Process feedstocks will be limited to cattle, swine, horse and poultry manures/litter and normal mortalities. The carbon to nitrogen ratio of some manures are in the desirable range while others will have to be adjusted with a carbon source for good composting and methane production. Methane is not a readily compressible gas which creates some storage limitations, therefore, direct contentious use of the gas as it is generated will be discussed. In this process, the nutrient content of the feedstock changes very little which will have to be utilized properly upon discharge from a digester. Litter from broiler and turkey production are ideal for further processing into organic fertilizer and other value added fertility products because they are from dry production systems with a high NPK content. In recent years, there has

been a lot of activity in direct combustion of poultry and turkey litter. A review of on and off farm combustion systems will be presented. Each of the alternatives shown will have their pros and cons and will be discussed.

Key Words: Waste Management, Composting, Organic Fertilizer, Combustion

9 Air quality, PM_{2.5}, and related concerns. F. M. Mitloehner, *University of California, Davis.*

Public concerns related to air quality impacts of intensive livestock and poultry operations have grown drastically over the recent years. Pollutants of concern are particulate matter, ammonia, methane, hydrogen sulfide, volatile organic compounds, and odors. However, there is a general paucity on character, amount, and dispersion of livestock air pollutants. Despite dramatic knowledge gaps, the Environmental Protection Agency (EPA), State and local air quality agencies are mandated to use best available emission factor data for their emission inventories. In serious non-attainment regions like the San Joaquin Valley, pollutants like particulate matter and ozone precursors have to be reduced significantly. New legislation forces livestock producers to reduce emissions using best available control methods that for the most part were never scientifically tested. The US Department of Agriculture (USDA) is mandated to support farmers with scientifically based emission mitigation techniques and technologies but again scientific information is scarce. Both, EPA and USDA appointed the National Research Council (NRC, 2003) to review the scientific basis for current emission estimates and emission mitigation. Major NRC findings were that current emission estimates are largely inappropriate because instead of being based on representative surveys from a class of operations (e.g., dairies) over several seasons, they are predominantly grab-sample measurements conducted on one operation at one time. The committee recommended replacing the current emission factor approach with the use of process-based modeling using nutritional mass-balance approaches. A second major NRC finding was that intensive research is needed into cost effective emission mitigation for livestock and poultry operations.

Key Words: Air Quality, Emission Mitigation, Emission Estimates

10 Water quality concerns—are they real? What needs to be done? T. G. Gunter*, *Oklahoma Department of Agriculture, Food, and Forestry.*

Many states continue to debate the question of whether or not animal agriculture is the cause of water quality pollution concerns. Using Oklahoma as an example, animal agriculture's potential impacts on water quality are often stated as the driving force behind legislative enactments restricting the activities of livestock or poultry operations. While animal agriculture can be a contributor to water quality problems, in many cases the real reason for the changes are related more to social or quality of life issues instead of water quality. Unfortunately, no matter what the state response is and no matter what the real reasons are behind that response, the results are livestock producers feel they are unfairly blamed for the entire problem and are subject to increasing regulation. Producer response to that regulation is ongoing and is likely

to shape the continuing evolution of animal agriculture in the U.S. and the world. This paper will provide the reader with an overview of Oklahoma's experience with the evolving world of livestock production, the state's reactions to real and perceived problems, producer reactions, and the future of animal agriculture and water quality.

Key Words: Water Quality, Livestock, Animal Agriculture

11 Urban encroachment and how Extension can assist farmers. K. S. Kremer, *Wartburg College, Waverly, IA.*

Development in the rural fringe of urban areas has eliminated both farm and timberland. While an assumption is often made that urbanization is destiny, this paper suggests communities, groups, and individuals can act to modify trends. This includes a role for university extension in their work with producers and communities.

Key Words: Urban Sprawl, Agricultural Change, Communities

12 Assimilation vs. accumulation of macro- and micro-nutrients in soils: relations to livestock feeding operations. N. A. Cole*, R. C. Schwartz, and R. W. Todd, *USDA-ARS Conservation and Production Research Lab, Bushland, TX.*

Amending soils with animal manures is a common practice to increase soil quality and dispose of potential wastes from concentrated animal feeding operations (CAFO). However, improper application of manure can result in runoff of nutrients or pathogens to surface water, percolation of nutrients to ground water, accumulation of nutrients in the soil, or loss of N and C to the atmosphere. The trend toward larger animal feeding operations has resulted in higher rates of manure and litter application in localized areas; thus, increasing the potential for pollution from land applied manure. With the advent of the new clean water regulations, all CAFO and many smaller AFO must have comprehensive nutrient management plans designed for proper utilization of manure nutrients. However, only 20 to 50% of CAFO have adequate land to meet application standards. The capacity of soils to accumulate nutrients, as well as the nutrient composition and phytoavailability of manures, vary greatly. In some cases, nutrients can accumulate in soils to the point of being toxic to plants. Application of manures to pastures is normally not sustainable because less than 20% of the nutrients applied leave the field in animal products. However, when forage is cut for hay or silage, appreciable quantities of applied nutrients can be exported. Areas adjacent to CAFO can receive large quantities of nitrogen via dry or wet deposition. These can be advantageous to some crops, but may be detrimental to plants sensitive to nutrient inputs such as native range or forests. Speciation data indicate that the relatively nontoxic dietary organic form of As (ROX) can be converted to the more toxic As(V) form in soils. For optimal sustainability, fertilization levels need to be balanced with plant requirements. However, even under the best management systems some accumulation or escape of nutrients is inevitable. Therefore, nutrient management plans must recognize the need to deal with nutrients that accumulate in soils or leave the field or production area.

Key Words: Manure Nutrients, Soil, Assimilation

Growth and Development: ASAS-Emerging Roles of Gut Peptides in the Regulation of Appetite and Metabolism

13 Role of PYY in Appetite Regulation during Obesity. C. W. le Roux*¹, S. Shurey², R. P. Vincent¹, M. A. Ghatge¹, and S. R. Bloom¹, ¹*Department of Metabolic Medicine, Imperial College London Hammersmith Hospital, London, UK,* ²*Experimental Surgery, Imperial College London Northwick Park Hospital, London, UK.*

PYY is present throughout the gastrointestinal tract, with the highest tissue concentrations in distal segments. PYY is released into the circulation following food intake and postprandial concentrations is proportional to meal size, with peak plasma levels appearing in the second hour. PYY reduces gastric emptying and delays gastro intestinal transit. Chronically elevated PYY have been described in several gastrointestinal diseases associated with loss of appetite. More recently, PYY has been demonstrated to have a physiological action inhibiting food in-

take through its action on the NPY Y2 receptor in the arcuate nucleus. Bariatric surgery remains the most effective treatment for obesity. In a rodent model of intestinal bypass PYY was elevated in the bypass compared to the sham bypass group. Humans following Roux-en-Y gastric bypass surgery for the treatment of obesity also have higher postprandial PYY responses and this might contribute to their increased satiety. In contrast, obese subjects treated with gastric banding had equivalent initial weight reduction, but do not demonstrate similar hormonal changes. The weight loss following gastric banding is not as long lasting as that observed after gastric bypass. Obese humans and diet induced obese mice have reduced fasting and an attenuated post-prandial PYY response. A greater meal calorie content is required to achieve similar PYY concentrations in obese compared to lean humans; postprandial satiety was also less in the obese. Infusions of exogenous PYY at increasing doses across the physiological range produced a graded increase

in satiety and reduced food intake in humans. These findings suggest that the lower postprandial PYY levels observed in the obese subjects might account for their reduced satiety response. Obese subjects may have a weaker PYY induced satiety signal for an equivalent meal, which could reinforce obesity. Current findings are consistent with PYY being a factor in appetite regulation.

Key Words: PYY, Obesity, Weight Loss

14 Proglucagon: A gene with diverse metabolic functions. D. Burrin*, *USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX.*

The proglucagon (PG) gene is expressed in the gastrointestinal tract (GI) and brain in several animal species. The PG gene is differentially translated in the GI tract by specific endocrine cells to produce glucagon in the pancreas and glucagon-like peptides 1 and 2 (GLP-1/GLP-2), glicentin, and oxyntomodulin in the intestine. These PG-derived peptides have diverse functions involving insulin secretion, motility, and tissue growth within the GI tract, but also have systemic actions on glucose homeostasis and appetite regulation. There is considerable interest in the therapeutic potential of GLP-1 and GLP-2 in respective treatment of type-2 diabetes and intestinal dysfunction, including short-bowel syndrome and inflammatory bowel disease. GLP-1 and GLP-2 are co-secreted from the gut in response to enteral nutrition, particularly fat and carbohydrate, but are suppressed by total parenteral nutrition. GLP-1 and GLP-2 secretion are also stimulated by short-chain fatty acids that are produced by colonic fermentation of malabsorbed carbohydrate and dietary fiber. GLP-1 is a key incretin hormone that increases insulin secretion, islet neogenesis, β -cell proliferation. GLP-2 is a potent intestinotrophic hormone that increases intestinal mucosal cell proliferation, blood flow and suppresses apoptosis and inflammation. The GLP-1/2 receptors are G-protein-coupled membrane proteins that signal via intracellular cAMP release. The GLP-1/2 receptors are expressed in the brain and GI tract; however, the cellular localization is poorly understood. There is limited information on the biological function of GLP1/2 in the growth and development of domestic animals. However, these hormones may be possible therapeutic targets for modulation of feed intake and intestinal dysfunction in production animals.

Key Words: Gut Hormone, Proglucagon, Metabolism

Antibiotics in Animal Feeds: Are There Viable Alternatives?

16 Novel preharvest strategies involving the use of inorganic and nitro-based compounds to prevent colonization of food producing animals by foodborne pathogen. R. C. Anderson*, Y. S. Jung, J. A. Byrd, K. J. Genovese, T. R. Callaway, T. S. Edrington, R. B. Harvey, and D. J. Nisbet, *USDA-ARS, Food & Feed Safety Research Unit, College Station.*

Foodborne diseases caused by enterohemorrhagic *Escherichia coli*, *Salmonella* and *Campylobacter* are of public health and economic significance. Shedding of these pathogens during production and slaughter are critical risks for contamination of products for human consumption. Consequently, strategies are sought to prevent or reduce the carriage of these pathogens in food animals before slaughter. Experimental products containing chlorate salts have been proven efficacious in reducing, by several hundred-fold, concentrations of *E. coli* and *Salmonella* in the gut of cattle, sheep, swine and poultry when administered as feed or water additives. Mechanistically, chlorate selectively targets bacteria expressing respiratory nitrate reductase activity, such as most members of the family *Enterobacteriaceae*, as this enzyme catalyzes the reduction of chlorate to lethal chlorite. Most beneficial gut bacteria lack respiratory nitrate reductase activity and thus the technology appears compatible with many bacteria exhibiting competitive exclusion capabilities. Research and development of the chlorate technology continues and a much improved product has been designed to increase passage of the active ion to the lower gut. More recently, select oxidized nitrogen compounds are being investigated as potential feed additives and while these nitrocompounds significantly reduce pathogens on their own, evidence indicates that they may most effectively be used to complement the bactericidal activity of chlorate. A particular attractive aspect of the nitrocompound technology is that as potent inhibitors of ruminal methanogenesis, they may allow producers the opportunity to recoup costs associated with their use. At present, neither chlorate nor the ni-

15 Gut peptides and feed intake regulation in lactating dairy cows. C. K. Reynolds*¹ and J. A. Benson², ¹*The Ohio State University, Wooster,* ²*The University of Reading, Reading, UK.*

For the modern dairy cow to achieve her potential for production with minimal body energy loss, nutritionists seek to maximize feed intake in early lactation. In contrast, a goal of modern human nutritionists is to reduce obesity by limiting appetite and energy intake in excess of requirement. In both cases, a clearer understanding of the factors regulating short- (meal size) and long-term (body fat) appetite and nutrient intake is needed. In future, new findings regarding the role of gut and hypothalamic peptides in rodents will undoubtedly prove relevant to the dairy cow. The portal-drained viscera (gut, pancreas, spleen and associated fat) produce a number of peptides which are demonstrated regulators of appetite, intake and nutrient utilization, and for many their release to peripheral tissues is modulated by liver removal. Insulin regulates acute and chronic intake in part through effects on nutrient use and the hypothalamus. Insulin secretion is modulated by a variety of nutrients, as well as 'incretin' peptides from the gut, such as glucose-dependent insulinotropic polypeptide and glucagon-like peptide 1 (GLP-1). In cattle, over half of immunoreactive glucagon released by the PDV is of gut origin (presumably oxyntomodulin and glicentin). Other products of proglucagon processing released by the PDV include pancreatic glucagon, GLP-1 and GLP-2. The active form of GLP-1 (7-36 amide) is one of an emerging group of gut peptides that inhibit intake through effects on gut function and the hypothalamus, which include cholecystokinin-8 (CCK8) and peptide YY (PYY). Evidence suggests an increase in CCK8 may be responsible for decreased DMI in lactating dairy cows fed fat, but in lactating cows abomasally infused with vegetable oils decreased DMI was associated with increased net PDV release and arterial concentration of GLP-1, while portal vein CCK8 concentration was reduced. Considering effects in other species, it is highly likely that PYY regulates intake and gut function in lactating dairy cows as well, but further research on the roles of gut peptides in ruminants is needed.

Key Words: Glucagon-like peptide-1, Cholecystokinin, Insulin

trocompounds have been approved as feed additives by the U.S. Food and Drug Administration and consequently, they are not yet available for commercial use.

Key Words: Food Safety, Foodborne Pathogen, Nitrocompound

17 Alternative to Antibiotics - Utilization of bacteriophage to prevent foodborne pathogens. W. E. Huff*, G. R. Huff*, N. C. Rath, J. M. Balog, and A. M. Donoghue, *USDA/ARS/PPPSRU Poultry Science Center, University of Arkansas, Fayetteville.*

Bacteriophage are potentially a safe alternative to antibiotic therapy. Bacteriophage lytic to a non-motile, serotype O2 isolate of *Escherichia coli* were isolated from municipal waste water treatment plants and poultry processing plants. This *E. coli* isolate is pathogenic to poultry, causing a severe respiratory and systemic infection. Two bacteriophage isolates were selected to use in studies designed to determine the efficacy of these bacteriophage to prevent and treat severe colibacillosis in poultry. Colibacillosis is induced by injecting 6×10^4 cfu of *E. coli* into the thoracic airsac when the birds are 1 week of age. Initial studies demonstrated that mortality was significantly reduced from 85% to 35% when the challenge culture was mixed with equal titers of bacteriophage, and the birds were completely protected when the challenge culture was mixed with 10^8 pfu of bacteriophage. In subsequent studies, we have shown that an aerosol spray of bacteriophage given to the birds prior to this *E. coli* challenge could significantly reduce mortality even when given 3 days prior to the *E. coli* challenge. Our research on treating colibacillosis in poultry has demonstrated that an intramuscular injection of bacteriophage given 24 or 48 h after the birds were challenged rescued the birds from this severe *E. coli* infection. Our research has

demonstrated that bacteriophage can be used to both prevent and treat colibacillosis in poultry and may provide an effective alternative to antibiotic use in animal production.

Key Words: E. coli, Bacteriophage, Therapy

18 Antibodies: an alternative for antibiotics? L. R. Berghman*¹ and S. D. Waghela², ¹*Departments of Poultry Science and Veterinary Pathobiology, Texas A&M University, College Station,* ²*Department of Veterinary Pathobiology, Texas A&M University, College Station.*

Infectious diseases of both humans and farm animals are re-emerging as significant problems, because our arsenal of effective anti-infective tools is not expanding proportionally. Thus, there is an urgent need for new approaches to the treatment of infectious disease, especially in cases of drug-resistant microbes, microbes for which therapy is not available, or in cases of host immune impairment. Recently developed technologies have opened up new avenues for the use of immunotherapy with pathogen-specific antibodies. While the idea is far from new (serum therapy in the early 1900s preceded the advent of antibiotics), for the approach to be affordable, an inexpensive, abundant source of specific antibodies is required. Polyclonal antibody sources therefore are limited to chicken egg yolk antibodies (also called IgY) and bovine colostrum antibodies. Numerous successful applications have been reported, ranging from treatment of rotaviral and cryptosporidial diarrhea to prophylaxis against dental caries. Monoclonal antibodies, while offering enhanced specificity, have long been disqualified, even for human treatment, due to lack of economical production systems. The recent introduction of transgenic animals and especially transgenic plants for production of therapeutic proteins has dramatically changed this perspective. Molecular farming of antibodies has made it possible to produce antibodies as complex as secretory IgA (sIgA) at a fraction (estimated at between 2-10%) of the cost of the conventional production systems. The plantibody approach is especially attractive for the production of recombinantly simplified antibodies, the so-called single chain variable fragments (scFvs). With decreasing cost of production, the potential to

tailor antibodies to very precise specifications and our increasing molecular knowledge of host-pathogen interactions, antibodies seem to have a bright future ahead as a redesigned tool for prophylaxis and treatment of infectious disease, both in animals and in humans.

Key Words: Antibodies, Therapy, Prophylaxis

19 Alternatives to Antibiotic Use - Natural food and feed amendments. S. C. Ricke* and M. M. Kunding, *Texas A&M University.*

Successful control of foodborne pathogens requires placement of antimicrobial hurdles during preharvest and postharvest food production. Chemical additives have traditionally included organic acids to control microbial contamination in animal feeds. However, there is some concern that continuous application of chemical antimicrobials can lead to a buildup of microbial resistance. This creates problems if foodborne pathogens evolve survival/resistance to a variety of environmental stressors that organisms encounter in pre- and postharvest animal production. To expand the diversity of potential antimicrobials that would have practical application for food animal production requires exploring the interaction between the food matrix and foodborne pathogens that become associated with it. Of particular interest is the potential for generating natural antimicrobial compounds during processing that originate from the food or feed. Possibilities include natural compounds formed during heating such as Maillard products and other chemically altered complexes and derivatives from foods and feeds which may possess antimicrobial properties for specific foodborne pathogens. Pathogens may also encounter natural antimicrobials in food products such as certain botanical compounds where they have historically been used for flavor enhancement as well as preservatives. Understanding the potential application for these natural compounds in foods and feeds will require examination of foodborne pathogen response under experimental conditions comparable to the environment where the pathogen is most likely to occur.

Key Words: Natural Antimicrobial Compounds, Foodborne Pathogens, Feed

Animal Behavior & Well Being I

20 Effects of photoperiod on the immune function of multiparous gestating sows. S. R. Niekamp*, M. A. Sutherland, G. E. Dahl, T. L. Auchtung, and J. L. Salak-Johnson, *Department of Animal Sciences, University of Illinois, Urbana.*

Photoperiod manipulation has provided a non-invasive, easily implemented, effective, method to improve immune status while enhancing productive efficiency in gestational dairy cattle. In this study, our objective was to evaluate the impacts of photoperiod manipulation on endocrine and immune responses of gestating sows. At d83 of gestation, sows were moved to gestation crates and kept on a 12L:12D photoperiod during an adjustment period. At d90, sows were allotted to either long day (LD; 16L:8D) or short day (SD; 8L:16D) photoperiod until farrowing. Blood samples were taken at d 90, 97, 103, and 110 of gestation to evaluate cortisol (CORT), prolactin (Prl), total white blood cell (WBC), lymphocyte (Lymph), and neutrophil (Neut) counts, IgG concentrations, lymphocyte proliferation (LPA), neutrophil chemotaxis (CHTX), and neutrophil phagocytosis (PHAG). At d97, IgG concentrations were higher ($p < 0.05$) in animals experiencing LD than those on SD. Sows on SD photoperiod had higher ($p < 0.05$) conacavalin A and LPS-induced ($p < 0.01$) LPA responses compared to LD sows. CORT concentrations also tended to be higher ($p = 0.18$) in SD than LD animals. At d103, the only treatment effect was on LPA in response to LPS which was higher ($p < 0.05$) in LD sows than SD animals. There were no treatment differences at d110. While there were treatment differences at certain time points, there were no trends of treatment effects over the period of the experiment. It appears that photoperiod is affecting immune status and endocrine responses but may have no long term effects. Further investigation is needed to determine the precise effects of photoperiod on gestational sows and their piglets.

Key Words: Sows, Immune, Photoperiod

21 Effects of photoperiod on immune function in 7 and 21 day old piglets. S. R. Niekamp*, M. A. Sutherland, G. E. Dahl, and J. L. Salak-Johnson, *Department of Animal Sciences, University of Illinois, Urbana.*

Photoperiod manipulation provides a non-invasive, easily implemented, effective, method to improve immune status while enhancing production efficiency. The objective of this study was to evaluate the impact of photoperiod manipulation pre- and post-gestational on piglet immune responses. Piglets' dams were subjected to either long day (LD; 16L:8D) or a short day (SD; 8L:16D) photoperiod at d90 of gestation. During farrowing-lactation some of the sows remained on their original photoperiod (LD:LD or SD:SD) treatment while others were switched to the opposite treatment (LD:SD or SD:LD). Blood samples were taken from piglets at 7 d of age for cortisol (CORT), total white blood cell counts (WBC), and IgG concentrations. At 21 d of age, blood samples were obtained for CORT, WBC, neutrophil counts (Neut), lymphocyte counts (Lymph), lymphocyte proliferation (LPA), neutrophil chemotaxis (CHTX), and neutrophil phagocytosis (PHAG). At 7 d of age, piglets subjected to LD:SD had higher ($p < 0.05$) total WBC compared to all other treatment groups. Plasma CORT was higher ($p < 0.05$) among piglets kept under a LD:SD photoperiod but lower among SD:SD and SD:LD treated piglets. Plasma IgG tended to be lower ($p < 0.07$) for piglets on SD:SD and SD:LD compared to animals on LD:LD and LD:SD photoperiod. At 21 d of age, piglets whose dams were on SD:LD had higher total WBC ($p < 0.05$) compared to all other treatment groups. LPA response to conacavalin A was higher ($p < 0.01$) among piglets on SD:SD than any other treatment group. A similar trend was apparent with LPA in response to LPS ($p < 0.07$). There was also a tendency for piglets subjected to LD:LD to have higher ($p < 0.1$) PHAG compared to animals on LD:SD. These data support the concept that photoperiod manipulation can alter immune function in piglets during gestation and before weaning.

Key Words: Piglet, Immune, Photoperiod

22 Farrowing performance and injury in a group housing system for gestating sows. M. J. Séguin*, T. M. Widowski, and D. Barney, *Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario, Canada.*

The University of Guelph research station converted one of two gestation rooms from 108 dry sow stalls to group housing with floor feeding. The new floor plan eliminated all alleyways, but was used to house the same number of sows (3.2m²/sow). Reducing the floor space allotment would make the system more economical. The objective of this study was to determine the performance and injuries of gestating multiparous sows housed in static groups at three floor space allotments and compare their performance records to that of the referent herd housed in stalls. Yorkshire sows were mixed after d 35 post-breeding into pens measuring 2.3, 2.8 or 3.2m² per sow. Group sizes ranged from 11-31. Body condition (5 point range) was scored upon entering and leaving gestation. The number and severity of superficial skin scratches on the shoulders (6 point range) were scored 24 h pre-mixing, 24 h post-mixing and on a weekly basis thereafter for five weeks. Mean, change and variation in body condition scores were not affected by group housing at any of the space allowances ($P > 0.1$), but the herd tends to be over-conditioned (average score: 3.5 ± 0.04). The day after mixing, 42.9 ± 8.3, 28.2 ± 7.7 and 28.0 ± 10.6 % of sows within a group had multiple skin scratches (scores 5-6) when housed at 2.3, 2.8 and 3.2m² per sow ($P > 0.1$), respectively. By two weeks post-mixing, most of the scratches had healed and by the end of the first month and for the remainder of gestation, fewer than 5% had multiple scratches. Shoulder scratches were a short-term consequence of group housing.

Farrowing performance (mean ± SEM)	2.3m ²	2.8m ²	3.2m ²	Stalls
Number of groups	4	5	6	.
Number of sows	88	77	82	98
# Born alive*	10.5±0.1	10.3±0.3	10.2±0.5	9.6±0.3
# Mummy	0.2±0.1	0.2±0.1	0.2±0.1	0.4±0.1
# Stillborn	1.0±0.1	0.9±0.1	1.2±0.1	1.4±0.2
Average Piglet Birth Weight (kg)*	1.59±0.01	1.61±0.03	1.56±0.03	1.52±0.03

*Mean of groups compared to sows in stalls as referent population ($P < 0.05$)

Key Words: Housing, Gestation, Sow

23 Application of guar hull by-product as a full-fed molting supplement. C. Zhang*, A. L. Cartwright, J. B. Carey, and C. A. Bailey, *Department of Poultry Science, Texas A&M University, College Station.*

A 5 × 5 Latin square experiment was conducted to explore the feasibility of molting hens by feeding relatively high concentrations (15 or 20%) of guar hull by-product. A total of 125 Bovan laying hens (64-week-old) of similar body weight were assigned to 5 groups of 5 replications with 5 hens in each replication, and were induced to molt by feed withdrawal (FW), or feeding 15 or 20% guar hull with or without β-galactomannase (Hemicell[®] at 250,000 unit/kg) for 14 days. Feed withdrawal birds, hens fed 15 or 20% guar hull without enzyme, and 20% guar hull with enzyme ceased laying at day 6, 10, 8 and 10 of treatment, respectively but hens fed 15% hull with enzyme continued to lay throughout the 14-day molting period. Feed withdrawal hens resumed laying in week 3 of post-molt, and reached 50% hen-day egg production in week 4. Full-fed groups laid eggs in the first week of post-molt, and reached 50% egg production in week 3. No differences ($P > 0.05$) were observed on egg production between FW hens and full-fed groups during the 8-week post-molt period, except that in week 7 fasted birds had lower egg production than the 20% guar hull-fed hens. The 20% guar hull-fed hens also had higher production than hens fed 15% hull with or without enzyme in week 6, 7 and 8. Fasted hens had higher mortality than all full-fed groups. All hens had higher egg weight, improved Haugh unit and shell quality, but decreased yolk color, when compared with the pre-molting period. No difference in egg quality was observed between each group except that FW hens had higher egg weights than full-fed hens. The results showed

that feeding guar hull by-product at 20% of complete diet may be a preferable molting approach to complete feed withdrawal.

Key Words: Guar, Laying Hen, Egg Production

24 A comparison of the behavior of broiler chickens raised on two different bedding types. S. J. Shields*, J. P. Garner, and J. A. Mench, *University of California, Davis.*

Exercise may be important for reducing leg problems in broiler chickens. A previous study (Shields et al., *in press*. Appl. Anim. Behav. Sci.) showed that sand bedding was preferred by broiler chickens for one form of exercise, dustbathing. The aim of this study was to determine the effect of sand bedding on the general behavioral activity of broiler chickens. In Experiment 1, 6 pens were divided down the center and bedded half with sand and half with wood shavings. Male broiler chickens (N=10/pen) were observed to determine day and nighttime behavioral time budgets on each side of the pens; nighttime behavior was videorecorded under red light. Each pen was observed 5 times per wk for 6 wk beginning when the chicks were 1 wk of age. Each observation period lasted for 1 hr during which scan samples of behavior were taken every 5 min. There was a significant behavior x bedding x week interaction ($F_{9,675} = 4.39, p < 0.0001$). During the day, drinking, dustbathing, preening, and sitting all increased on the sand (to 2.0%, 1.9%, 3.1% and 37.7 % of the time budget, respectively) but decreased on the wood shavings (to 0.1%, 0.0%, 1.1%, and 22.1% of the time budget). At night, resting increased on the sand (from 13.9% to 61.2% of the time budget). In Experiment 2, eight pens (N=50 birds/pen) were bedded either in sand or wood shavings. In contrast to the first experiment, bedding type did not affect time budgets (GLM: $F_{12,566} = 0.53, p = 0.8946$) or dustbathing ($F_{1,38} = 0.12, p = 0.73$). Thus, while in the first experiment some active behaviors were performed increasingly more often on the sand side of the pens, the results of the second experiment indicated that broilers will use wood shavings for these behaviors if it is the only substrate available. Therefore, although sand is a preferred substrate, providing sand bedding is unlikely to increase overall activity levels.

Key Words: Broiler Chicken, Behavior, Sand Bedding

25 Incidence of bone breakage in three strains of end-of-lay hens. K. L. Budgell¹ and F. G. Silversides^{2,3}, ¹*Nova Scotia Agricultural College, Truro, Nova Scotia,* ²*Crops and Livestock Research Centre, Charlottetown, Prince Edward Island, Canada,* ³*Pacific Agri-Food Research Centre, Agassiz, British Columbia, Canada.*

Bone fragility in commercial end of lay hens leads to breakage before slaughter which is a significant welfare concern, and after slaughter which is a concern because it reduces the value of the carcass. When 72 weeks old, 180 spent hens of three genetic lines were slaughtered at a provincially inspected plant. The carcasses were subsequently frozen for storage, then thawed and dissected to determine the number of bone fractures. Fractures were separated into those that showed signs of healing, an indication of breakage before shipping, those surrounded by tissue trauma, indicating breakage during depopulation and shipping, and those with no healing or soft tissue damage, indicating that they occurred after the hens were dead. Two lines of commercial layers, ISA-Brown and Babcock B300, had higher incidences of old (11.1% and 11.7%) and shipping breaks (7.9% and 10.0%) than a heritage line of Brown Leghorns (0.0% and 3.5% respectively). Most bones were broken during processing, and all hens had at least some broken bones. The ISA-Brown and Babcock B300 hens had a higher average number of breaks (13.5 and 18.9 respectively per bird) than Brown Leghorn hens (8.7 per bird). The majority of breaks were of the pubis, ischium, sternum, and rib cage, with 97.8, 90.6, 89.4, and 71.7% respectively of the hens experiencing breaks in these bones by the end of evisceration. These results show that spent laying hens suffer broken bones before, during, and after depopulation and slaughter. Differences between the lines in the incidence of broken bones suggest that selection of commercial layers for high egg production may have affected bone strength.

Key Words: Layers, Strains, Bone Breakage

26 Unexpected estimates of variance components with a true model containing genetic competition effects. L. D. Van Vleck*¹ and J. P. Cassady², ¹USDA-ARS, Roman L. Hruska U.S. Meat Animal Research Center, ²North Carolina State University.

Simulation of the model of Muir and Schinckel containing genetic competition effects was initiated to determine how well REML could untangle variances due to direct and competition genetic effects and pen effects. A two-generation data set was generated with 6 unrelated males, each mated to 5 unrelated females to produce 300 progeny from which 30 females (one per mating in previous generation) were mated to 6 unrelated males to produce 300 more progeny. Progeny were randomly assigned 6 per pen to 50 pens per generation. Parameters were V_g , V_c , C_{gc} , V_p and V_e representing direct and competition genetic variance with covariance, and pen and residual variance. Eight statistical models were used to analyze each of 400 replicates of 16 sets of parameters. Both V_g and V_e were fixed at 16. Values of C_{gc} were -2, -1, 0.1, 1 and 2. Values of V_c were 1 and 4 and of V_p were 0.1, 1, and 10. With the full model, average estimates resembled true parameters except that V_p was consistently overestimated when small (0.1 and 1) which, in turn, slightly changed other estimates. The most unexpected result was overestimation of V_p when V_c and C_{gc} were ignored in the analysis. The overestimation depended on V_c and number of competitors in common between records in a pen. The upward bias was greater when C_{gc} was positive than when negative. For example, with $C_{gc} = 2$, $V_c = 4$ and $V_p = 0.1$, mean estimate of V_p was 20.4 when C_{gc} and V_c were dropped from the model and 15.3 when $C_{gc} = -2$. When V_p was ignored, estimates of both C_{gc} and V_c increased proportional to V_p . Also V_g increased more with greater V_p . Another unexpected result was that when pen was considered fixed for the analysis, sampling standard errors of estimates of C_{gc} and V_c were reduced generally by factors of 2 to 30. These results suggest that a high estimate of pen variance may indicate genetic competition effects are important and that ignoring pen effects will bias estimates of other components.

Key Words: Genetic Parameters, Pen Effects, Simulation

27 An animal model with autoregressive covariance structures among residual and genetic effects for genetic evaluation of Holstein cows with test day records. R. M. Sawalha*¹, J. F. Keown², S. D. Kachman², and L. D. Van Vleck³, ¹University of Nebraska, Lincoln, ²Department of Statistics, University of Nebraska, Lincoln, ³USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Lincoln, NE.

This study was to evaluate an animal model with first order autoregressive covariance structures (AR1) among residual and genetic effects of test day (TD) records. This model was compared with a simple TD repeatability model and a 305-day lactation model. Data consisted of 106,472 test day records of 12,071 first lactation Holstein cows. Estimates of components of variance and autocorrelation coefficients were obtained for milk, fat, and protein yields and somatic cell scores (SCS) using ASReml. Likelihood ratio tests indicated that AR1 model was significantly more appropriate for the TD data than the simple repeatability model for all four traits. Estimates of heritability were slightly lower for yield traits (0.09) with AR1 model than with simple TD repeatability model (0.10-0.11). Estimates of heritability with 305-d yield traits were in the range of 0.14 to 0.36. For SCS, both TD models resulted in similar estimates of heritability of 0.06. Estimates of residual variance were probably underestimated with simple repeatability model compared with AR1 model. Average estimates of accuracy of PBV for all traits were always higher with simple repeatability model than with AR1 model for both sires and cows. The least change in rank of the top 100 elite sires and cows was between the two TD models (4-9% for sires). The greatest difference in ranking of elite animals was between simple repeatability model and 305-d model (26-36% for sires). Similar patterns were also observed for values of correlation among PBV of different models. The AR1 model resulted in similar or slightly lower correlations between actual lactation records of cows and the averages of PBV of their parents compared with the simple repeatability model. Average PBV tended to increase with advancement of lactation for yield traits and to decrease for SCS. Averages of PEV of PBV were highest at the beginning and at the end of lactation.

Key Words: Milk Yield, Test Day, Autoregression

28 Detection of different shapes of lactation curve in cattle by standard mathematical models. N. P. P. Macciotta*¹, D. Vicario², C. Di Mauro¹, and A. Cappio Borlino¹, ¹Dipartimento di Scienze Zootecniche Via De Nicola 9, 07100 Sassari, Italia, ²ANAPRI Via Nieveo 19, 33100 Udine, Italia.

Four mathematical models of lactation curve (Wood WD, Wilmik WIL, Ali and Schaeffer AS parametric models and Legendre fifth order polynomials LEG) were fitted to individual milk yield patterns of 27,837 Italian Simmental cows, each having at least 7 records. Aims of the work were: i) to assess goodness of fits; ii) to check sensitivity of models in discriminating different shapes of lactation curve; iii) to analyse relationships among curve shapes and parameter values and (co)variances. About 70% of individual regressions showed an adjusted $R^2 > 0.75$ for all models. Among these best fits, three-parameter models (WD and WIL) detected two main families of curve shape, the typical curve (with a first increasing phase till a peak followed by a declining phase), and the so-called atypical curve, characterised only by the declining phase. AS and LEG models assigned most of lactation patterns to the two main families but, due to their greater flexibility, around 15% of curves were allocated in about 10 other not well defined forms. Each family of curve shape had a specific combination of signs of parameters. Range of absolute values of parameters and correlations among them were similar in the two families highlighted by WD and WIL models, whereas differences among some families were detected by AS and LEG functions. The great heterogeneity of lactation curve shape could explain some problems encountered in the analyses that require comparison between parameter values and estimation of their (co)variances, as the anomalous variance of estimated yields at the first phase of lactation. The drastic solution to discard atypical lactations could not be applied when the occurrence of these patterns is relevant, as in the present study (about 30%). An alternative solution suggested by results of this study could be to perform separate analysis within each of the main family of lactation curve shape.

Key Words: Mathematical Models, Lactation Curve Shape, Parameter Values

29 Impact on calving ease evaluations of excluding herds with abnormal distribution of scores. C. P. Van Tassell, G. R. Wiggins, and L. L. M. Thornton*, Animal Improvement Programs Laboratory, Agricultural Research Service, USDA Beltsville, MD.

Threshold model sire and maternal grandsire (MGS) calving ease evaluations for the United States were calculated after excluding two sets of 10% of the data. Herds were excluded based on χ^2 goodness of fit test. To determine the first set of herds to be excluded, frequencies of observed (O) records were determined by parity (1 vs. 2+) and difficulty score (1-5). Expected (E) numbers of records were calculated as the total number of calvings by parity multiplied by the fraction of difficulty scores across all herds in each parity. Goodness of fit values were calculated as the sum of $(O-E)^2/E$ across parity and difficulty score. The 299 herds failing this test tended to be large. The second set of 8605, mostly small herds, was identified using frequencies in place of counts. Evaluations were calculated using data from all years or only calvings before 1999. Pedigree indexes ($0.5 \times \text{sire} + 0.25 \times \text{MGS}$) were calculated from two earlier data sets (abnormal distribution herds included or excluded). Correlations were calculated between pedigree index and solutions from evaluations for bulls with at least 30 calvings in the complete data. Correlations were higher between solutions from sets with abnormal distribution herds excluded. For the first set of excluded herds, for sire solutions, the increase was from .579 to .599 for 25,067 bulls, and for MGS, from .598 to .617 for 21,221 bulls. For the second set, the increases were .004 greater. Differences between evaluations from early and complete data were also examined. Variances of these differences and mean and maximums of the absolute values of differences tended to be larger when the first set of abnormal distribution herds were excluded. These differences are likely due in part to the reduction in total data represented in the predicted breeding values. The differences tended to be smaller when the second set was excluded. These improvements indicate that the evaluations should better predict

future performance when data from herds with abnormal distributions is excluded.

Key Words: Calving Difficulty, Dystocia, Abnormal Distribution

30 Effects of heteroscedasticity on sires' predicted transmitting ability in grazing and confinement herds. A. G. Fahey*, M. M. Schutz, D. L. Lofgren, A. P. Schinckel, and T. S. Stewart, *Purdue University, Lafayette, IN.*

The number of grazing (G) herds in the USA is increasing. Heteroscedasticity (HV) of data may affect the ability of sires' predicted transmitting ability (PTA) to predict actual performance of daughters. The objective of this study was to investigate the effect of HV on the predictability of PTA for mature equivalent (ME) milk (MEM), ME protein (MEP), and ME fat (MEF) for daughters in G and confinement (C) herds. Data consisted of 366 G herds from 11 states with 72,489 records and 373 C herds from 12 geographically similar states with 117,629 records. Herds were divided into mean quartiles (Q_{M1} - Q_{M4} , from low to high) and variance quartiles (Q_{V1} - Q_{V4}) based on MEM, and a transformation was applied to reduce HV. The method of transformation was to standardize the within herd variance to the average variance of a base year for each parity, and was similar to that used in the USDA-DHIA genetic evaluations. Coefficients of regression (RC) of daughter yield on PTA in G herds indicated that PTA overestimated daughters' production for all traits in Q_{M1} - Q_{M3} ($P < 0.01$) and for MEF in Q_{M4} ($P < 0.05$). In C herds, RC in Q_{M1} and Q_{M4} for MEP and in Q_{M1} , Q_{M2} , and Q_{M4} for MEF were less than unity ($P < 0.05$). After transformation, changes in RC for G herds were negligible. For C herds, only the RC for MEP in Q_{M4} was different from unity ($P < 0.05$). Analysis within variance quartiles also showed that PTA overestimated production of all traits in Q_{V1} - Q_{V3} ($P < 0.01$) and MEM in Q_{V4} ($P < 0.05$) in G herds. For C herds, yields of MEM in Q_{V1} and Q_{V2} ($P < 0.05$), and of MEP ($P < 0.01$) and MEF ($P < 0.01$) in Q_{V1} were overestimated; MEP was underestimated in Q_{V4} ($P < 0.05$). Reducing HV had little effect on G herds; but for C herds, RC was no longer different from unity for MEM and MEP in Q_{V1} and Q_{V2} . Production was more accurately predicted by PTA in C herds than G herds. Accounting for HV had little effect on the predictability of PTA, indicating that observed scaling effects do not arise solely from effects of HV.

Key Words: Heteroscedasticity, Predicted Transmitting Ability, Grazing

31 Effects of heteroscedasticity on the heritability and genetic correlations of production traits in grazing and confinement herds. A. G. Fahey*, M. M. Schutz, D. L. Lofgren, T. S. Stewart, and A. P. Schinckel, *Purdue University, West Lafayette, IN.*

Grazing (G) herds in the USA are increasing in number. Heteroscedasticity (HV) of data may bias estimates of genetic correlation (r_G) for yield traits between environments, an indicator of genotype-by-environment interaction (GxE). The objective of this study was to investigate the effect of HV on estimates of heritability (h^2) and r_G for mature equivalent (ME) milk (MEM), ME protein (MEP), and ME fat (MEF) yield of daughters in G and confinement (C) herds. Data consisted of 366 G herds from 11 states with 72,489 records and 373 C herds from 12 geographically similar states with 117,629 records. Herds were divided into mean quartiles and variance quartiles based on MEM. A transformation was used to reduce HV. The method of transformation was to standardize the within herd variance to the average variance of a base year for each parity, and was similar to that used in the USDA-DHIA genetic evaluations. In G herds, estimates of h^2 were near 0.19, 0.19, and 0.20 for MEM, MEP, and MEF. For C herds, h^2 from lowest to highest quartile. Estimates of r_G between G and C were greater than 0.89 in all mean quartiles, implying little GxE. Reducing HV by transforming yield records had little effect on h^2 or r_G . For variance quartiles, h^2 fluctuated as variance quartiles increased. For MEM, MEP, and MEF, h^2 were approximately 0.17, 0.17, and 0.19, respectively. The r_G for yield traits between C and G environments within each variance quartile suggested a GxE only for the lowest quartile for MEM. Transforming the records had negligible effects on the h^2 and r_G for variance quartiles. For G and C herds, h^2 were similar for all traits. The r_G near unity for the highest variance quartiles suggests that traits in both environments are controlled largely by the same genes. Reducing HV did not affect

estimates of h^2 or r_G , indicating that modest evidence for existence of GxE, especially in the lowest quartile, did not arise solely from HV.

Key Words: Heteroscedasticity, Heritability, Genotype-By-Environment Interaction

32 Segregation analysis of milk flow in Swiss dairy cattle by Bayesian approach. H. Ilahi and H. N. Kadarmideen*, *Statistical Animal Genetics Group, Institute of Animal Science, Swiss Federal Institute of Technology (ETH) Zurich ETH Zentrum (UNS), CH-8092 Zurich, Switzerland.*

Segregation analyses via Gibbs sampling were applied to investigate the mode of inheritance and to estimate the genetic parameters of milk flow of 3 breeds of Swiss dairy cattle. Data consisted of 204,397, 655,989 and 40,242 lactation records of milk flow in Brown Swiss (BS), Simmental (SM) and Holstein (HO), respectively (collected in the last 4 to 22 years). Number of animals in pedigree ranged from 343,969 to over 1 million (1,013,610) animals. Separate segregation analyses of first and multiple lactations were carried out for each breed by an individual animal model, implemented by Gibbs sampling algorithm with blocked sampling of genotypes and a polygenic model for first lactation data sets of all breeds by Restricted Maximum Likelihood Method. Genetic parameters of milk flow were very similar under both mixed inheritance (polygenes and major gene) and polygenic models. Estimated marginal posterior means of additive and dominance effects of the major gene were 0.016, 0.010, 0.023 for first lactation data set of BS, SM and HO, respectively and 0.013 and 0.012 for multiple lactations data set of BS and SM, respectively. Segregation analyses yielded very low major gene variances which favor the polygenic determinism of this trait, in contrast to confirmed mixed inheritance of this trait in dairy goats. Heritabilities and repeatabilities of milk flow in both BS and SM were high (0.44 to 0.48 and 0.54 to 0.59, respectively), however the heritability of this trait (based on scores of milking ease) in HO was intermediate (0.25). Variance components and heritabilities in the first lactation were slightly larger than those estimates for multiple lactations especially for error variances. Our results suggest that milk flow (quantity of milk per minute of milking) is a relevant measurement to characterize cows milking ability which is a good candidate trait to be included in selection program in dairy cattle.

Key Words: Segregation Analysis, Milk Flow, Bayesian Method

33 Prediction of longevity breeding values for U.S. Holstein sires using survival analysis methodology. D. Z. Caravillo*, K. A. Weigel, and D. Gianola, *University of Wisconsin, Madison.*

Breeding values of Holstein sires for daughter longevity in each of nine geographical regions of the US were predicted using a Weibull proportional hazards model. Longevity was defined as days from first calving until culling or censoring after correction for within-herd-year 305-d mature equivalent production. Records from 2,322,389 Holstein cows with first calving from 1990 to 2000 were used. In addition to the sire's additive genetic merit, the failure time model included time-dependent effects of herd-year-season of calving, parity-stage of lactation, and within-herd-year quintiles for mature equivalent fat plus protein yield, as well as the time-independent effect of age at first calving. The relative risk of culling for daughters of each individual sire was expressed relative to that of a daughter of an average sire (within a specific region). Predicted breeding values for functional longevity, expressed as relative risk ratios, ranged from 0.7 to 1.3. Sizable differences in sire rankings were observed between geographical regions, suggesting that a single national ranking may not hold in every region. Substantial differences in estimates of the sire variance and the gamma parameter of the distribution of herd-year-season effects occurred between regions. Two random samples of herds were selected from the full national data set; these samples contained 375,086 records and 256,751 records, respectively. PTA of sires for daughter longevity were compared with predictions from a linear (animal) model, as currently used for routine national (US) genetic evaluation of length of productive life. Logistic regression of daughters' stayability to 36, 48, 60, 72 or 84 months of life, among animals that had opportunity to stay that long, on sires predicted transmitting ability indicated that the proportional hazards model yielded more accurate predictions of daughter longevity than the linear animal model, even though the latter relies on more dense pedigree information.

Key Words: Longevity, Survival Analysis, Holsteins

Breeding and Genetics: Genetics of Dairy Health Traits

34 Potential for inclusion of health data in international genetic programs. P. D. Miller*, *University of Wisconsin, Madison.*

Genetic selection programs for dairy cattle in many countries are reviewed, breeding goals are compared, and the degree of uniformity that exists and is required for international genetic programs for health traits is discussed. The most prevalent health disorders in dairy cattle are mastitis, infertility, lameness, milk fever, ketosis, metritis, and displaced abomasums. The manifestation of these disorders can be partly attributed to management and environmental factors, but there is evidence that each also has a genetic component. Health traits are genetically correlated with traits for which international genetic evaluations are routinely available from Interbull, including milk production, conformation, and udder health traits. Evaluations for longevity (length of herd life) are expected this summer. Genetic evaluations for female fertility traits are available in many countries and international evaluations are imminent. Effective selection using quantitative genetic approaches requires measurement and recording of phenotypes and frequent evaluation of candidates for selection. Producers use many different definitions to record health data and do not use a standardized format in on-farm or DHIA databases. Change will require significant time and effort by many people. Direct genotyping using DNA technologies offers potential for direct selection for genes causing health problems, but this is likely to be a slow and incomplete solution. Potential exists for genetic improvement of health in dairy cattle. Economic, social, and political forces will shape the changes that occur.

Key Words: Health, Genetic, International

35 Genetic basis and risk factors of infectious and noninfectious diseases in US Holsteins. I. Estimation of genetic parameters for single diseases and general health. G. Abdel-Azim¹, A. E. Freeman², M. E. Kehrli³, S. C. Kelm⁴, J. L. Burton⁵, A. L. Kuck¹, and S. Schnell¹, ¹*Cooperative Resources International, Shawano, WI*, ²*Department of Animal Science, Iowa State University, Ames*, ³*National Animal Disease Center-USDA-ARS, Ames, IA*, ⁴*Animal & Food Science Department, University of Wisconsin, River Falls*, ⁵*Michigan State University, East Lansing.*

Health data collected over a period of four years, 1996 to 1999, from 177 herds in Minnesota and Wisconsin were analyzed to establish genetic basis for infectious and noninfectious diseases. Three types of health traits were targeted, first, selected infectious conditions were fit together in a statistical model to identify animals that are superior in their general immunity for infectious diseases. Generalized immunity may be thought of as a combination of immune responses to a variety of immune system challenges. Second, single infectious and noninfectious diseases were analyzed separately. Third, infectious reproductive diseases as one category of related conditions and cystic ovary disease as one category of 3 related noninfectious ovary disorders were studied. Data were analyzed by a threshold model that included herd, year, season of calving, parity, sire, and cow as cross-classified factors. Days at risk and days in milk at the start of the trial were adjusted for by fitting the days as continuous covariates in the model. A heritability value of 0.202 ± 0.083 was estimated for generalized immunity. Heritability values of 0.141 and 0.161 were estimated for uterine infection and mastitis, respectively. Heritability of single noninfectious disorders ranged from 0.087 to 0.349. The amount of additive genetic variance recovered in the underlying scale of noninfectious disorders tended to 0 when combining together multiple conditions. Therefore, although the study is in favor of combining infectious diseases into categories of interest, we do not recommend the same approach for noninfectious disorders because of the different mechanisms controlling them.

Key Words: Disease Resistance, Generalized Immunity, Genetic Evaluation

36 Multivariate genetic parameters for health, reproduction, body condition score, and conformation traits in Swiss Holsteins. H.N. Kadarmideen*, *Statistical Animal Genetics Group, Institute of Animal Science, Swiss Federal Institute of Technology (ETH) Zurich ETH Zentrum (UNS), Ch-8029 Zurich, Switzerland.*

Data on body condition score (BCS), days to first service (DFS), non-return rate (NRR), somatic cell count (SCC), and 305-day yields of milk, fat and protein from 38,930 multiple lactation records of cows, daughters of 243 sires in 1830 herds were used to estimate genetic parameters. Single- and multi-trait repeatability animal models were used to estimate parameters based on restricted maximum likelihood methodology. Fixed effects in the model varied depending on the individual trait. Further, genetic relationships between 27 (linear and descriptive) type traits and functional traits (fertility and SCC) were estimated by regressing daughter type records on their sire estimated breeding values for functional traits, using the same data set. BCS had a moderate heritability (h^2) of 0.26 and fertility traits had low h^2 (0.12 for DFS and 0.06 for NRR). Heritability of SCC and milk production traits was 0.14 and around 0.30, respectively. BCS had favorable genetic correlations with fertility traits (-0.35 with DFS and 0.04 with NRR) suggesting that BCS could be considered in a fertility index. BCS had a favorable genetic correlation (r_g) with SCC, but not strong (-0.08). Selecting for milk production alone would lead to decline in genetic merit for functional traits considered here, as milk production has antagonistic r_g with fertility (range 0.12 to 0.27 with DFS and -0.12 to -0.24 with NRR), with BCS (-0.39 to -0.50), with SCC (0.10 to 0.15). Many type traits (especially udder traits) had a favorable genetic relationship with fertility traits and somatic cell counts whereas dairy character had an unfavorable genetic relationship. Results (genetic correlations) suggest that future selection indexes may include BCS (possibly also dairy character) as an indicator of fertility with appropriate (high) economic weights while including production traits with (less) optimal economic weights.

Key Words: Reproduction, Body condition score, Genetic correlations

37 Estimation of genetic parameters for health traits in large commercial herds using data recorded in on-farm herd management software programs. N. R Zwald* and K. A Weigel, *University of Wisconsin, Madison.*

The objective of this study was to estimate genetic parameters for clinical mastitis, lameness, metritis, ketosis, and displaced abomasum using data recorded on commercial dairy farms. Disease incidence data were recorded in one of three herd management programs: DC305, PCDART, or DHIPLUS. Data were collected directly from 141 herds that participated in the Alta Genetics Advantage progeny test program, and Dairy Records Management Systems provided data from an additional 160,264 cows in 438 herds that routinely recorded health disorders. Incidence rates on were: 14.1%, 10.4%, 5.4%, 4.9%, 2.2%, for mastitis, lameness, ketosis, metritis, and displaced abomasum respectively. In the genetic analysis, herds were required to have a recorded incidence rate of $>1\%$ for ketosis, metritis, and displaced abomasum and $>3\%$ for mastitis and lameness. After removal of herds with incomplete reporting and cows with unknown sires or sires with < 5 daughters, data included: Clinical mastitis: 441 herds, 143,592 cows and 4505 sires Lameness: 228 herds, 79,413 cows, and 1109 sires Displaced abomasum (DA): 326 herds, 106,998 cows, and 2165 sires Metritis/Retained Placenta: 471 herds, 148,885 cows, and 2162 sires Ketosis: 133 herds, 44,335 cows, and 730 sires A threshold sire model was used. The model for early metabolic disorders (metritis, ketosis, and DA) was response = HYS + Lactation + sire. A three-trait model, treating occurrences of disease in each of the first three lactations as separate traits, was used for mastitis and lameness. This model was response = HYS+ stage of lactation + sire. Heritability estimates ranged from 0.06 to 0.11. Cases of ketosis, metritis, and DA were combined in an analysis of early metabolic health. Due to the binary nature of these traits, relationships between traits, and low incidence rates combining traits into an early metabolic health index has great potential for implementation in a selection program.

Key Words: Early Metabolic Disorders, Progeny Test, Genetic Parameters

38 Health parameters in F1 Jersey x Holstein, backcross (Jersey x Holstein) x Holstein, and pure Holstein calves. C. Maltecca* and K. Weigel, *Department of Dairy Science, University of Wisconsin, Madison.*

The present study is part of a larger project that aims to detect quantitative trait loci (QTL) affecting health, fertility, calving ease, and milk composition in a crossbred Holstein x Jersey cattle population. Fecal and respiratory scores and birth weights were recorded for F1 Jersey x Holstein, backcross (Jersey x Holstein) x Holstein, and pure Holstein calves on two farms. Fecal and respiratory scores were measured on a five-point scale of severity. Ninety two pure Holstein calves (41 females and 51 males) and 31 F1 Jersey x Holstein calves (15 females and 16 males) were from a commercial dairy in Wisconsin, while 60 pure Holstein calves (31 females and 29 males) and 35 crossbred calves (15 females and 20 males) were from the University of Wisconsin experimental herd. Mean Fecal scores were 1.36 (\pm 0.37) and 1.49 (\pm 0.38) for Holstein calves in the commercial and experimental herds, respectively. Corresponding means were 1.22 (\pm 0.16) and 1.44 (\pm 0.24) for F1 Jersey x Holstein calves and backcross (Jersey x Holstein) x Holstein calves, respectively. Mean respiratory score were 1.03 (\pm 0.01) and 1.10 (\pm 0.09) for Holstein calves on the commercial and experimental farms, respectively, and 1.04 (\pm 0.02) to 1.18 (\pm 0.12) for F1 and backcross calves, respectively. Mean birth weights for calves from multiparous dams in the experimental herd were 42.7 (\pm 3.3) and 39.2 (\pm 6.7) for Holstein males and females and 40.2 (\pm 7.4) and 41.2 (\pm 3.3) for backcross males and females, respectively. Mean birth weights for the commercial herd were 45.1 (\pm 6.4) and 42.0 (\pm 6.4) for Holstein males and females and 35.7 (\pm 3.4) and 31.4 (\pm 3.9) for backcross males and females, respectively. Differences between pure Holstein, F1 Holstein x Jersey, and backcross (Holstein x Jersey) x Holstein calves for scours and respiratory score were not significant.

Key Words: Calves, Backcross, Health

39 Application of a finite mixture model to somatic cell scores of Italian goats. P. Boettcher*¹, D. Gianola², G. Pisoni³, C. Vimercati³, M. Rinaldi³, and P. Moroni³, ¹IBBA-CNR, Segrate, Italy, ²University of Wisconsin, Madison, ³University of Milan, Milan, Italy.

Mastitis infection usually results in high concentrations of somatic cells (SCC) in the udder of affected animals. Data on SCC from infected and uninfected mammary glands can be viewed as drawn from many statistical distributions with different means and, possibly, different variances. Information on bacterial infection is often not available to indicate the distributions from which a given data point originates, but an analysis with finite mixture models can account for this uncertainty by assigning each record to a given distribution with a certain probability. The objective was to apply such an analysis to data for SCC in dairy goats. Data were 1378 test-day records of SCC and presence of bacteria in each of the udder halves of 92 primiparous goats in five Italian herds. The approach regarded all observations from a given udder half as arising from the same distribution. The fit of a single component (standard) model with mixtures of two or three distributions was examined. From a biological standpoint, a two-component model would be appropriate if observations from healthy and infected udder halves were from two different distributions and a three-component (or more) model would be appropriate if bacterial species differed in their effect on SCS. The two-component model was able to separate distributions that differed in mean by 0.89 SCC (log 2), or approximately 0.30 standard deviations. The proportions of the "low" and "high" SCS components were approximately 60 and 40%, respectively. The ability of the analysis to assign observations to different distributions according to bacterial presence was tested. A clear association with bacterial infection was observed. For example, observations from udder halves with no bacterial infection were assigned to the component with a low mean SCS with a probability of 65%. In contrast, udder halves with bacterial presence at eleven test days were assigned to the high group with a 70% probability. The three-component model was unable to distinguish separate distributions. Application of a mixture model in genetic evaluations may improve selection programs based on EBV for SCC.

Key Words: Somatic Cell Score, Goats, Mixture Model

40 Test day model evaluation for production traits and somatic cells score for the Italian Holstein. F. Canavesi*, S. Biffani, and F. Biscarini, *ANAFI Via Bergamo 292,26100, Cremona, Italy.*

In the past three years the Italian Holstein association in cooperation with Canadian Dairy Network (CDN) has been working toward the development of a random regression test day model evaluation for milk, fat, protein and somatic cell score (SCS). The model is a multiple trait, multiple lactation test day animal model with fixed effects of herd-test day-parity. A Legendre polynomial of 4th order is used to fit the fixed effect of age-parity-region-season and the random effects of the animal and of the permanent environmental effect. Heritability for production traits is on average 0.30 the same parameter used for the official evaluation based on lactation records. Heritability of SCS is 0.17 in first, 0.21 in second and 0.25 in third lactation respectively, much higher than the present 0.08 value used for genetic evaluation based on first lactation test day records with a repeatability test day model. The correlation with the official sire production proofs is around 0.97 for yield traits and 0.70 for SCS. For cow proofs the correlation is around 0.92 for production traits and 0.69 for SCS. The first official publication is expected before the end of 2004.

Key Words: Test Day Model, Genetic Evaluation, Random Regression

41 Crossbreds of Normande-Holstein, Montbeliarde-Holstein, and Scandinavian-Holstein compared to pure Holsteins for production and SCS during the first 150 days of first lactation. B. J. Heins, L. B. Hansen*, and A. J. Seykora, *University of Minnesota, St. Paul.*

Normande-Holstein (NxH) crossbreds (n = 171), Montbeliarde-Holstein (MxH) crossbreds (n = 194), and Scandinavian-Holstein (SxH) crossbreds (n = 120) were compared to pure Holsteins (H, n = 294) for milk, fat, and protein production and SCS during the first 150 days of lactation of first lactation. Cows were housed in seven commercial dairies in California and calved from June 2002 to December 2003. Dependent variables for analysis were test-day observations from DHI. All Holstein sires and all Holstein maternal grandsires were required to have an NAAB sire code to assure they were A.I. sires. Normande, Montbeliarde, and Scandinavian crossbreds were all daughters of A.I. sires via imported semen. Independent variables were breed (H, NxH, MxH, SxH), random effect of sire within breed, random effect of cow within sire and breed, stage of lactation (4-30 d, 31-60 d, 61-90 d, 91-120 d, 121-150 d), herd-year-season (3-mo seasons within the seven herds), age at calving (linear, months), milking frequency (2X, 3X), and PTA of Holstein maternal grandsire (linear). Breed was significant for all traits. Least squares means for fat plus protein were 2.03 kg (H), 1.90 kg (NxH), 2.05 kg (MxH), and 2.18 kg (SxH). Relative to production of pure Holsteins on a percentage basis, differences were -6% (NxH), +1% (MxH), and +7% (SxH). Least squares means for SCS were 2.13 (H), 2.40 (NxH), 2.33 (MxH), and 1.88 (SxH).

Key Words: Crossbreeding, Production, SCS

42 Accuracy and stability of national and international somatic cell score evaluations. R. L. Powell*, A. H. Sanders, and H. D. Norman, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Most research on accuracy of dairy bull genetic evaluations has been with yield traits. This report focuses on somatic cell score (SCS) evaluations. International evaluations through Interbull (IB) have been available since May 2001. February 2004 U.S. and IB SCS PTA were matched with U.S. and IB PTA from May 2001 (US04, IB04, US01, and IB01, respectively) for 14,821 Holstein bulls. All four evaluations were required for each bull. Over the three years, the means were essentially the same (increased 0.001) in each system (U.S. and IB). Correlations of 0.96 and regressions of later on earlier PTA of 0.99 were nearly as expected. Bulls adding substantially to numbers of U.S. daughters had mean increases in PTA of about 0.01 and regressions of nearly unity but correlations between earlier and later PTA were about 0.04 lower than expected considering reliabilities. The US01 and IB01 PTA were compared as predictors of US04 where IB01 PTA included data from at least one other country. As expected, US01 was the better predictor where it contained essentially the same daughters as US04, but IB01 was better when U.S. daughters increased at least 25%. Mean PTA difference

from US04 was closer to zero, standard deviation of the differences was smaller, and correlations were higher. The advantage in correlation from IB01 increased with the amount of new U.S. data in the 2004 evaluation. Both U.S. and IB evaluations were stable on average, increasing in mean only slightly. Regressions were essentially unity in both systems. Correlations were less than expected by about 0.01 overall and lower by 0.04 for subsets with substantial added data. Inclusion of foreign data in addition to U.S. data improved the prediction of later U.S. SCS evaluations.

Key Words: Genetic Evaluation, Somatic Cell Score, Interbull

43 Genetic component of heat stress. S. Oseni, I. Mistral*, S. Tsuruta, and R. Rekaya, *The University of Georgia, Athens.*

A norm reaction model was used to estimate the genetic parameters of days open (DO) and pregnancy rate (PR) under heat stress. Data included DO records for GA, TN and NC. Pregnancy rate was computed as $PR = \min\{1, 1/[(DO-50)/21-1]\}$. PR, unlike DO, assigns greater weight to smaller DO records. Fixed effects model included herd-year-month of calving, age of the cow, and a regression on 305-d milk yield. The norm-reaction model additionally included the effect of animal with random regression on a heat index, which was normalized solutions to months of calving from the fixed model; residual variance was assumed to be a function of the heat index. The shape of the heat index for DO (PR) was close to sinusoidal (triangular) function with the highest value in April (May) and the lowest value in October (October). For DO and PR, genetic and residual variances and heritabilities were highest for spring calvings and lowest for fall calvings. For DO (PR), the variance associated with the highest level of heat index was 33% (33%) of the genetic variance of the regular effect. Genetic correlation between regular and heat stress effects for DO (PR) was 0.67 (-0.65). As a validation process, DO was computed with the model above, without the heat stress index and the months of calving grouped into four seasons treated as multiple traits. In general, the genetic and residual variances of the multiple trait model followed those of the norm-reaction model for DO.

Dairy Foods: Chemistry

45 Utilization of front face fluorescence spectroscopy for rapid analysis of process cheese functionality. S. K. Garimella Purna*, L. A. Prow, and L. E. Metzger, *University of Minnesota, St. Paul.*

The purpose of this study was to evaluate the feasibility of front face fluorescence spectroscopy (FFFS) to predict the functional properties of process cheese spreads. A total of 27 different commercial samples from three different manufacturers were used in this study. Each sample was analyzed using tube melt test and dynamic stress Rheometry (DSR). The tube melt data is a measure of cheese flow in mm, whereas the DSR data was used to calculate the melt temperature (temperature at $\tan\delta = 1$). Additionally fluorescence spectra of tryptophan (excitation: 290nm; emission: 305-400 nm) were collected on each sample at 20°C using a front face accessory. Six replicates were taken from each sample and six scans were performed on each replicate. After collection the curves were normalized and the mean curve was baseline corrected. Multivariate statistical analysis was used to correlate the fluorescence data with the functionality data. In the initial analysis two samples with large spectral and concentration residuals were eliminated from the calibration set. The calibration models were developed using partial least square regression (PLS). The analysis included preprocessing using mean centering and verification using cross validation. A correlation coefficient of 0.90 and 0.82 between the fluorescence spectra and the functionality data was obtained for the DSR and tube melt respectively. The regions from 309-315 nm and 355-395 nm of the tryptophan spectra had highest correlation to DSR; while the tube melt data had the highest correlation between 334-348 nm. Examination of the tryptophan spectra indicated that an increase in the melt temperature measured by the DSR resulted in a blue shift in the spectra. These spectral shifts have been related to the protein conformational changes due to change in the environment of tryptophan residues present in the protein. These results indicate that the melt properties of process cheese spreads are related to molecular structure that can be measured using FFFS.

Key Words: Fluorescence, Process Cheese, Functionality

Genetic correlations of spring with summer, and fall with winter were 0.97 and 0.98, respectively. Genetic correlations between spring/summer and fall/winter were around 0.8. The norm reaction model for DO allows inexpensive but limited genetic evaluation of fertility under heat stress. Results of such an evaluation may strongly depend on the editing criteria and on the details of the model.

Key Words: Days Open, Pregnancy Rate, Heat Index

44 Use of peeling and reverse peeling to estimate the power to map a recessive disease gene. L. R. Totir*, R. L. Fernando, and J. M. Reecy, *Iowa State University, Ames.*

Animal pedigrees containing individuals that exhibit the phenotype of a recessive disease (e.g. dwarfism) can be used to map the causative recessive disease gene by performing a genome scan. When planning a linkage study, however, it is important to know beforehand the number of animals that must be genotyped and the marker density needed to have sufficient power to locate the disease gene. Conditional on the observed disease phenotypes, reverse peeling can be used to sample genotypes at the disease locus and at two flanking marker loci. Given the sampled genotypes and the observed disease phenotypes, peeling can be used to compute the logarithm of the likelihood ratio (LOD score). By replicating this process, the power to detect the disease locus can be estimated by calculating the frequency of samples where the LOD score is larger than 3. This strategy was applied to an Angus cattle pedigree of 39 animals including six affected individuals. For this pedigree we studied the behavior of the power to map a disease gene as a function of the number of animals genotyped, and the size of the marker interval. It was determined that, for this pedigree, the power to map a disease gene was larger than 90 percent for marker intervals equal to or smaller than 15 cM. This strategy can be used to design genome scans to map disease genes with adequate power.

Key Words: Power, Peeling, Recessive Disease Gene

46 Modified milk vs. producer milk samples for calibrating infrared (IR) milk analyzers: which gives the best validation performance? K. E. Kaylegian*¹ and D. M. Barbano^{1,2}, ¹Dept. of Food Science, Cornell University, Ithaca, NY, ²Northeast Dairy Foods Research Center, Ithaca, NY.

Nine IR milk analyzers were calibrated with modified milk samples and nine different IR analyzers were calibrated with producer milk samples. No single lab had more than two instruments. The population of instruments represented three different manufacturers, several different models, and FTIR and filter based instruments. The validation study was replicated three times with different calibration and validation samples. Labs that calibrated analyzers with producer samples used their normal calibration samples and procedures. Modified milk samples (n = 14) were made from pasteurized gravity separated cream, skim milk UF retentate and permeate, lactose, and water. Validation samples (n = 12) were raw individual producer milks. Both the modified milk calibration set and the producer milk validation set were preserved with dichromate and analyzed by all labs using chemical reference methods (ether extraction, Kjeldahl, and oven drying) to produce all lab mean reference values. Validation of individual instruments was assessed by the mean difference (MD) and standard deviation of the difference (SDD) between the IR predicted values and all lab mean reference chemistry values. Comparison of the two calibration sample types was done using Euclidian distance plots. The range of MD for fat, true protein, and total solids tests on the validation set across labs was reduced by 30% or more for analyzers calibrated with modified milks vs those calibrated with producer milks. In general, the SDD was lower for analyzers calibrated with modified milks vs those calibrated with producer milks.

Key Words: Infrared Milk Analysis, Calibration, Validation

47 Rapid impedance method to detect adulterated milk. D. L. Marshall* and G. M. Duran, *Food Science and Technology Dept, Mississippi State University, Mississippi State.*

Illegal milk adulteration can reduce cheese yield, slow fermentation rates, and reduce milk quality. To detect adulteration, a cryoscope is used to measure milk freezing point. Because changes in solute concentration affect the freezing point, some adulteration practices that add water also include addition of salt, sugar, or dried milk powder to increase solids content to maintain freezing point and fool the cryoscope. At certain solid-to-water adulteration ratios, the cryoscope gives readings that indicate the milk was unadulterated. Impedance technology, which analyzes resistance to flow of electrical currents, is used by the dairy industry to measure product quality and estimate shelflife. The purpose of the present study was to investigate whether impedance can be utilized to detect added salt water in milk. In this study, adulterated milk samples were prepared by adding various amounts of salt solutions to whole milk, resulting in concentrations of 0, 0.01, 0.02, 0.03, 0.04, and 0.05% salt, and 0, 1, 2, 3, 4, and 5% water. Freezing points of the samples were determined using a cryoscope and Impedance I-values were determined using a Bactometer. The Bactometer was unable to detect added water in the absence of salt. With water alone added in increasing amounts, the cryoscope readings showed an R^2 of 0.994, while the Bactometer had an R^2 of 0.2. In contrast, the Bactometer was able to easily detect the addition of salt. R^2 for the Bactometer and cryoscope readings were 0.998 and 0.843, respectively, for varying salt concentrations. The Bactometer was able to rapidly detect (6 minutes) salt-water additions even when the cryoscope could not. The cryoscope was more effective than the Bactometer at testing milk or milk with added water, but the Bactometer was superior at detecting adulteration with salt water. Because many dairy plants use a Bactometer microbiological testing, it could be used as a supplemental test to the cryoscope to determine if milk is adulterated.

Key Words: Impedance, Cryoscope, Milk Adulteration

48 Characterization of flavor and flavor compounds in dried whey protein concentrates and isolates. M. Carunchia Whetstone*, M. Drake, and A. Croissant, *North Carolina State University, Raleigh.*

Dried whey and whey protein are important food ingredients. Functionality of whey products has been studied extensively, but flavor has not been systematically studied. Flavor inconsistency and flavors which may carry through to the finished product can limit whey ingredient applications in dairy and non-dairy foods. The application of analytical sensory and instrumental methods to identify and characterize specific flavors and the chemicals that cause specific flavors enhances our understanding of whey ingredients. The objectives of this research were to identify and characterize sensory flavor and volatile aroma-active compounds that contribute to flavor in whey protein concentrates (WPC) and isolates (WPI). Seven WPC80 and 8 WPI samples, less than three months old, were collected in duplicate from 6 different manufacturers. Samples were rehydrated and evaluated in duplicate by descriptive sensory analysis ($n=7$). Duplicate samples with internal standards were extracted with diethyl ether, followed by isolation of volatile material by high vacuum distillation. Volatile extracts were analyzed using gas chromatography-olfactometry (GCO) with post peak intensity analysis. Compounds were identified by comparison of retention indices, odor properties and GC-MS data against reference standards. Selected compounds were quantified by standard addition. Sensory analysis of model systems was used to confirm the relationship between selected compounds and specific flavors. Whey proteins were variable in flavor and exhibited cardboard/wet paper, animal/wet dog, soapy, brothy, cucumber, and cooked/milky flavors, along with the basic tastes sweet and bitter, and the feeling factor astringency. Key volatile flavor compounds in WPC80 and WPI were guaiacol (burnt/smoky), 2-nonenal (fatty/old books), (E,E)-2,4-nonadienal (fatty/oxidized), (E,Z)-2,6-nonadienal (cucumber), (E,Z)-2,4-decadienal (fatty/oxidized), and dodecanal (waxy/soapy). Baseline data on flavor and flavor sources in whey proteins will aid in the identification of methods to control or minimize flavor variability.

Key Words: Whey Protein Flavor, Gas Chromatography Olfactometry, Sensory Analysis

49 Effect of fat type and fat globule surface coating on the volatile fatty acid profile of yogurt. D. W. Everett*¹, J. Crownshaw¹, A. Ginestet², R. Wierda¹, M. Leus¹, and J.-P. Dufour¹, ¹University of Otago, Dunedin, New Zealand, ²Ecole nationale supérieure de biologie appliquée à la nutrition et l'alimentation, Dijon, France.

Yogurt (20 g) was manufactured containing either soy oil or anhydrous milk fat (AMF) globules coated with one of four materials: two spray-dried buttermilk powders (BMP), casein, or freeze-dried milk fat globule membrane (MFGM) produced by centrifugation at 15°C. Natural fat globules in yogurt was used as a control. Skim milk was standardized to 5% casein by ultrafiltration. Soy or AMF emulsions were prepared at 75 MPa using a Microfluidizer, and added to the concentrated skim to a fat:casein ratio of 4:3. *Mucor miehei* rennet protease was added to duplicate samples. Yogurt was cultured with *Lactobacillus bulgaricus* and *Streptococcus thermophilus* at 31°C until pH 5.5, stored for 122 days at 12°C, then kept at -80°C before analysis by gas chromatography (GC). Samples were heated at 50°C for 60 minutes and volatile components adsorbed onto carboxen/polydimethylsiloxane solid phase microextraction fibers. Fatty acids were identified by GC- mass spectrometry, and peak areas measured using GC with flame ionization detection. Standard plate counts of the four milk powders were less than 10³ cfu/g at 32°C. The rennet protease had no significant effect on GC peak areas. C4 acid concentration was 10-fold higher for AMF compared to soy yogurts. For soy yogurts, MFGM coating gave a 3-fold increase in C4 acid compared to the other coatings, a 2-fold decrease in C5 and C7 acids, and a 2-fold increase in C8 and C10 acids. No trends were evident for C6, C9, or C12 acids. Casein and both BMP coatings gave similar fatty acid profiles. For AMF yogurts, natural fat globules produced a 30 to 100-fold increase in C4 acid compared to the other coatings, a 10-fold increase in C5 acid, and no evident trend for the other fatty acids. Comparing AMF and soy yogurt, AMF produced 5-10 times more C4 acid, 3-6 times less C7 acid, 2-3 times more C8 acid, 2-3 times less C9 acid, and 2 -6 times more C10 acid. The low heat MFGM generated a greater amount of even numbered fatty acids compared to casein or the high heat treatment BMP. The nature of the fat globule coating evidently impacts upon lipolysis in yogurt.

Key Words: Yogurt, Volatile, Lipolysis

50 The influence of non-fat dry milk characteristics on yogurt functionality. A. Pollard* and L. E. Metzger, *Department of Food Science and Nutrition, University of Minnesota, St. Paul.*

Yogurt functionality, especially non or low fat yogurt is almost entirely dependent on the characteristics of the milk solids used in the formulation. Yogurt formulation utilizes a high proportion of non fat dry milk (NFDM) either as base material, or for fortification purposes to achieve appropriate solids concentration. Variation in milk solids characteristics can cause substantial differences in yogurt viscosity and syneresis. The characteristics of NFDM can vary markedly due to many factors including method of production (spray drying conditions), date of production (seasonal changes), and storage conditions. Currently there is no method of determining the functional characteristics of NFDM samples other than solubility tests. Unfortunately, solubility tests do not provide an accurate prediction of the characteristics of the NFDM samples when used for yogurt manufacture. To address the issue of NFDM functionality, a measurement technique using a Rapid Visco Analyser (RVA) was developed. In this method, a NFDM sample is added to water (50%w/w), and mixed at a high shear rate (950RPM) for 5 minutes at 70°C. Subsequently, the sample is heated from 70°C to 92°C over 18 minutes with continuous mixing at 150RPM. During the entire test, the viscosity profile is recorded using the RVA. In a preliminary study, seven low-heat NFDM samples were analyzed using this method. In this test, viscosity profile varied significantly for different samples even though all samples were low heat NFDM. Non fat yogurts at 15 and 20% total solids were then manufactured using the NFDM samples. A significant correlation between RVA viscosity profile and yogurt viscosity was observed at both solids levels (R^2 of 0.84 for 15% total solids, 0.92 for 20% total solids) and yogurt syneresis at 15% solids only (R^2 of 0.85 for 15% total solids). This indicates that the viscosity of NFDM measured in the RVA can be used to predict functionality of the NFDM when used for yogurt manufacture. This should be of great interest to commercial

manufacturers as it allows a quick, easy and cheap test to determine the functionality of the NFDM samples used for yogurt manufacture.

Key Words: NFDM, Yogurt, RVA

51 Characteristics of κ -casein stabilized emulsions treated with rennet. R. Richter, G. Anita*, G. Perez-Hernandez, and B. Davis, *Texas A&M University, College Station.*

The objective of this research was to determine if gels could be formed from κ -casein stabilized emulsions by treatment with rennet. Emulsions were prepared with κ -casein separated from acid casein (Cayot et al. 1992) and butteroil. The compositions of the emulsions were 0.3% κ -casein and 3, 10 or 20% fat. The pre-emulsion mixtures were heated to 65°C before homogenization at 20 or 100 MPa and cooled to room temperature. CaCl₂ was added to emulsions to obtain a concentration of 20 mM. A 0.1% solution of rennet (200 μ l) was added to 30 ml emulsion samples. Rheological properties were measured before and after the

addition of rennet. The effect of fat concentration and homogenization pressure on the rheological properties of the emulsions was determined. Emulsion behaved as Newtonian fluids before the addition of rennet with mean viscosities of 1.21, 1.45 and 2.12 cP for emulsions containing 3%, 10% and 20% fat respectively. The addition of rennet caused yield stress in all of the emulsions and the viscosity increased to 3.59, 18.18 and 51.17 cP for emulsions that contained 3%, 10% and 20% fat respectively. The mean viscosity of the emulsions increased from 20 cP when emulsions were homogenized at 20 MPa to 26 cP when emulsions were homogenized at 100 MPa. Under the studied conditions, κ -casein gels could not be formed. However, yield stress was observed on the κ -casein emulsions treated with rennet. The changes on the rheological properties depended upon the composition of the emulsions and the pressure applied during homogenization.

Key Words: κ -casein, Rennet, Rheological properties

Forages and Pastures: Management of Tall Fescue Forage

52 Performance of beef heifers grazing stockpiled endophyte-infected, endophyte-free or non-toxic endophyte-infected fescue. E. J. Oliphant*, M. H. Poore, J. T. Green, and M. E. Hockett, *North Carolina State University, Raleigh.*

A 70-d study was conducted from Dec 20 to Feb 28 in order to evaluate heifer performance on Jesup endophyte-infected (E+), endophyte-free (E-) and non-toxic endophyte-infected (EN) tall fescue. Botanical composition and nutrient content of each treatment (tmt) was also evaluated. Forty-eight Angus cross heifers (initial wt 269 kg, initial body condition score 5.1) were placed in groups of 4 and randomly assigned to 12 paddocks (avg 1.25 ha). Paddocks were fertilized with 95 kg of N per ha on Sept 24, and forage was stockpiled until the initiation of the trial. Heifers were given a daily allotment of forage with a target residual height of 5 cm. Mineral containing monensin (1780 mg/kg) was available ad lib. The initial grazable mass was higher ($P < 0.06$) for E+ (1443 kg/ha) than for E- (1100 kg/ha) or EN (1233 kg/ha). Daily gains did not differ by tmt (0.33, 0.42 and 0.45 kg/d for E+, E- and EN, respectively). Forage grab samples were taken at 14-d intervals starting Dec 2, and subsamples were separated into green fescue, brown fescue and species other than fescue (primarily crabgrass). There were no differences in nutrient content among tmt within green or brown fescue tissue: (E+ green: 43.3% NDF, 19.8% ADF, 11.75% CP; brown: 67.1% NDF, 34.3% ADF, 7.75% CP), (E- green: 42.5% NDF, 19.3% ADF, 11.62% CP; brown: 66.8% NDF, 33.9% ADF, 7.76% CP), (EN green: 43.6% NDF, 19.9% ADF, 11.25% CP; brown: 68.1% NDF, 34.6% ADF, 7.35% CP). From Dec to Feb, percent green fescue decreased in all tmt ($P < 0.01$) with no significant difference among tmt. Percent fescue in the sward DM was higher ($P < 0.01$) in E+ (87.8%) and EN (87.5%) than in E- (81.1%). Nutrient content of the sward declined ($P < 0.01$) over the winter, but average nutrient composition was similar across tmt: E+ (52.0 % NDF, 25.5 % ADF, 10.96 % CP), E- (52.2 % NDF, 26.1 % ADF, 11.16 % CP) and EN (52.1 % NDF, 25.4 % ADF, 10.53 % CP). These results indicate that endophyte status of stockpiled fescue may have little influence on animal gain or forage quality during the winter grazing season.

Key Words: Endophyte, Fescue, Beef Heifers

53 Calving rate and production responses of long-term exposure to endophyte-infected tall fescue. J. M. Burke*, D. K. Brauer, and M. L. Looper, *USDA, ARS, Booneville, AR.*

The objective was to examine the effect of continuous exposure to endophyte-infected (EI) tall fescue on pregnancy, calving rates, and calf growth in cow-calf pairs. In April 1999 and 2000, Angus and Angus x Hereford cows were randomly assigned to graze 16 ha endophyte-free (EF; n = 20/yr) or 24 ha EI (n = 30/yr). From spring 2000 until fall 2003 cows were continuously exposed to each forage. Heifers were bred in April and cows were bred in May for a 90 and 60 day breeding period, respectively. Cows were removed or culled from treatments if they did not conceive or lost a pregnancy or calf. Cows grazing EI fescue were supplemented daily with 0.5 kg/cow of corn/SBM for 90 d in winter so that body condition scores were similar between EF and EI cows by

April. At weaning (early October) pregnancy rate, determined by transrectal ultrasound, and calving rate were similar between pasture groups and length of time on pasture. Calving interval tended to be reduced in cows grazing EI fescue the first year ($374.0 \pm 4.8 < 386.2 \pm 4.4$ d; forage \times exposure; $P < 0.06$). Percent of cows culled or that died between forage treatments was similar. Despite supplemental feeding of EI cows over winter, body weight (forage \times exposure \times days postpartum, $P < 0.03$) and condition scores (1 = emaciated, 9 = obese; forage \times exposure \times days postpartum, $P < 0.001$) were greater in cows grazing EF fescue. Body weight and condition were greater in cows exposed for 3 to 5 years in both forage groups compared to those exposed to forage for 1 or 2 years. Birth weights of calves born to cows exposed to 2 years were reduced compared with 1 or 3 to 5 years of EI fescue exposure (forage \times exposure, $P < 0.008$). However, by weaning, the 205 day adjusted weaning weight was similar among exposure groups and greater in EF compared with EI calves ($224.3 \pm 3.8 > 199.7 \pm 2.4$ kg; $P < 0.001$). In summary, number of years of exposure to EI tall fescue did not greatly impact cow-calf performance.

Key Words: Beef, Production, Tall fescue

54 In situ digestibility of tall fescue fertilized with different swine manure treatments and harvested on four dates. J. L. Reynolds¹, R. K. Ogden¹, K. P. Coffey*¹, W. K. Coblenz¹, C. V. Maxwell¹, and K. VanDevender², ¹University of Arkansas, Fayetteville, ²Cooperative Extension Service, Little Rock, AR.

Forage digestibility varies across a growing season due to factors such as fertility and harvest date. Our objective was to evaluate the in situ DM digestibility of tall fescue (*Lolium arundinacea*, Schreb.) fertilized with different swine manure treatments and harvested on different dates. "GA-Jessup" tall fescue infected with a non-ergot alkaloid producing endophyte (Max-Q[®]) was either not fertilized (CONT), or fertilized (126 kg N/ha) with normal swine manure (NORM); swine manure from pigs fed phytase (PHY), or PHY treated with aluminum chloride (PHY+AL). Accumulated forage was harvested by clipping with hand shears (2.5 cm stubble height) on April 3, April 28, May 16, and June 23, 2003. Ruminally cannulated steers (n=5; 548 kg BW) were used to evaluate these forages in situ. Degradation rate of DM was greater ($P < 0.05$) from NORM and PHY than from CONT and decreased ($P < 0.05$) with advancing harvest dates through the May 16 harvest. A fertility treatment by harvest date interaction was detected ($P < 0.05$) for most variables. The slowly degradable (B) fraction, potential extent of degradation, and effective ruminal degradability were higher ($P < 0.05$) on April 3 and 28 than on May 16 and June 23 from all fertility treatments. The soluble (A) fraction, fraction B, potential extent, and effective degradability were greater ($P < 0.05$) from fertilized than CONT fescue harvested April 3, but the improvement was not consistent across harvest dates. By May 16 and June 23 harvests, fraction B and potential extent were greater ($P < 0.05$) from CONT than from fertilized fescue. Effective ruminal degradation was not consistently impacted by fertility treatment after April 3. Therefore, inclusion of phytase in swine diets along with subsequent treatment of the manure with aluminum chloride did not

have consistent impacts on forage degradation compared with normal swine manure. Furthermore, fertilization with swine manure increased effective degradation of fescue initially, but the impact was not consistent at later harvest dates.

Key Words: Swine Waste, Phytase, Tall Fescue

55 Selenium concentration of fescue and bahiagrasses after applying a selenium fertilizer. G. Valle, L. R. McDowell*, D. L. Wright, and N. S. Wilkinson, *University of Florida, Gainesville.*

Two experiments were conducted, one with bahiagrass (August to November) in North Central Florida (Gainesville) and the other with fescue (January to July) in Northwest Florida (Quincy), to evaluate the selenium levels of the grasses after applying a slow release selenium fertilizer (Selcote Ultra). The hypothesis is that selenium fertilizer would elevate forage selenium to acceptable levels for ruminant requirements. In the bahiagrass study, forage samples were collected from 3 x 5 m plots replicated 4 times which had been sprayed with Selcote Ultra at randomized treatment rates of 0, 5, 10, 15 and 20 g ha⁻¹ selenium. Samples were collected every two weeks for a total of six collections. In the fescue study, the procedure was the same except that forage samples were collected at 2, 4, 6, 10, 16 and 22 wk after applying the fertilizer, and the rates were 0, 5, 10, 24 and 120 g ha⁻¹ selenium. For bahiagrass, only the 10, 15 and 20 g ha⁻¹ selenium treatments reached acceptable levels in the forage (>0.1 ppm) for beef cattle. The 10 g ha⁻¹ selenium treatment reached adequate levels (0.25 ppm) only at 4 wk after application. The 15 g ha⁻¹ selenium treatment presented adequate levels of selenium at 2, 4 and 6 wk after application (0.19, 0.17 and 0.17 ppm, respectively). The 20 g ha⁻¹ selenium treatment had adequate forage selenium at 4 and 6 wk after application (0.19 and 0.23 ppm respectively). All treatments were deficient at 8 and 12 wk. In the fescue study, all treatments presented adequate concentrations (0.1 ppm) of selenium in the forage, except for the control. At two weeks after application, the 24 g ha⁻¹ and the 120 g ha⁻¹ selenium treatments had toxic selenium levels in forage. However, these values declined to below toxicity (4-5 ppm) at all other collection dates. In conclusion applying Selcote was more effective for fescue than bahiagrass, with fescue forage selenium still more than adequate 22 wk after application.

Key Words: Selenium, Fertilizer, Forage

56 Rumen parameters of cattle grazing tall fescue pastures differing in endophyte status. A. M. Corrigan*, J. C. Waller, A. M. Saxton, L. C. Miller, and C. J. Richards, *The University of Tennessee, Knoxville.*

Objectives of this experiment were to compare weight and composition of rumen contents and substrate *in situ* degradation in steers grazing tall fescue (*Festuca arundinacea* Schreb.) pastures. Pasture treatments consisted of continuous grazing of Kentucky-31 endophyte (*Neotyphodium coenophialum*) infected (E+), Jesup endophyte-free (E-) or Jesup infected with a non-ergot alkaloid producing endophyte (MaxQ). The d was separated into two 12-h grazing periods. Day grazing (DG) was from 0700 to 1900 and night grazing (NG) was from 1900-0700. Two ruminally cannulated steers were randomly assigned to each pasture in early May 2003. After a 7 d acclimation period, steers were subjected to four rumen evacuations NG at 0700 and four DG at 1900. Contents were weighed and sub-sampled. Evacuated rumens were washed and steers were returned to appropriate pastures for 45 min to obtain masticate samples. Between the four evacuation days, alfalfa hay, corn grain, corn gluten feed, and soybean hulls *in situ* degradation was determined for the NG and DG periods by placing a 5 g sample of each substrate, within a 10 x 20 cm Dacron bag, into each steer consuming the three forage treatments. After a 12-h incubation, Dacron bags were mechanically washed and dried. Rumen content, masticate, *in situ* substrate, and *in situ* incubated residue samples were analyzed for DM, NDF, ADF, and CP. Rumen DM contents for steers grazing E- and MaxQ were greater ($P < 0.05$) than steers grazing E+ and DG contents were heavier ($P < 0.01$) than NG. *In situ* DM, NDF, and CP degradation of corn grain was greater ($P < 0.05$) in steers grazing E- and MaxQ than in steers grazing E+. *In situ* alfalfa hay and corn gluten feed DM, NDF, and ADF degradation appeared greater ($P < 0.15$) in steers grazing E- and MaxQ than in steers grazing E+. Soybean hull degradation was not

affected by pasture. Generally, nutrient degradation of substrates was not affected by incubation time (NG vs DG).

Key Words: Tall Fescue, Degradability, Endophyte

57 Use of novel endophyte-infected tall fescue for cow-calf production in Arkansas. J. M. Burke*, D. K. Brauer, and M. L. Looper, *USDA, ARS, Booneville, AR.*

The objective was to examine pregnancy, calving rates, and calf growth in cow-calf pairs on endophyte-free (EF), novel endophyte-infected (NE), and endophyte-infected (EI) tall fescue. Angus cows grazed EF, NE ($n = 20/16$ ha), or EI ($n = 30/24$ ha) starting November 2001 through July 2003. To prevent overgrazing, NE cattle were removed from July to November 2002 and in May 2003. Hay was provided as needed during winter. Pastures were fertilized at a similar rate among fescue varieties with N, P and K in early March and October both years. Cows were bred beginning in May for 60 d. Cows were removed if not pregnant at weaning or lost a pregnancy or calf after calving and replaced with a comparable pregnant cow or cow-calf pair that had previously grazed bermudagrass (for EF and NE groups) or EI (for EI group) fescue. Forage yields were determined monthly in exclusions ($n = 3$ /pasture) in 2003. Yield of EI was greater than EF or NE from April to June and EF and EI forage yield was greater than NE in August (forage x month, $P < 0.02$). Cows grazing EF fescue gave birth to heavier calves than those grazing EI ($P < 0.04$) and NE calf weights were similar to EF and EI weights (EF, 38.3 ± 0.7 ; NE, 36.7 ± 0.7 ; EI, 36.3 ± 0.6 kg; $P < 0.10$). Between May and July 2002, EF and NE calves were heavier than EI calves (forage x time, $P < 0.001$); however, calf weights were similar in May 2003 among forage groups ($P = 0.15$). At weaning (early October 2002) pregnancy rate, determined by transrectal ultrasound, was greater in NE than EI cows ($P < 0.03$) and similar between EF and EI cows (EF, 70.9 ± 9.7 ; NE, 96.2 ± 9.8 ; EI, $67.8 \pm 8.6\%$; $P < 0.07$). By spring, calving rates were similar among forage groups (EF, 70.0 ± 10.7 ; NE, 80.2 ± 10.9 ; EI, $63.2 \pm 9.5\%$; $P = 0.35$). In summary, calf gains from cows grazing NE fescue were greater than EI calves. However, the use of NE fescue as a summer forage at a similar stocking rate as EI (1 cow/0.8 ha) is limited in Arkansas because of overgrazing potential.

Key Words: Beef, Novel endophyte, Tall fescue

58 Using orchardgrass and endophyte-free fescue versus endophyte-infected fescue overseeded on bermudagrass for cow herds: four-year summary of cattle performance. W. K. Coblenz*, K. P. Coffey, D. A. Scarbrough, T. F. Smith, D. S. Hubbell, III, K. F. Harrison, B. C. McGinley, J. E. Turner, and J. B. Humphry, *University of Arkansas, Fayetteville.*

A four-year trial was initiated in January 2000 with 65 spring-calving cows (549 ± 23.0 kg) to evaluate cow-calf performance on pastures with endophyte-infected tall fescue (IF; *Festuca arundinacea* Schreb.), endophyte-free (FF) tall fescue, or orchardgrass (OG; *Dactylis glomerata* L.) overseeded into dormant common bermudagrass [*Cynodon dactylon* (L.) Pers.]. Two management systems were evaluated to help FF and OG forages persist; these included rotations to new paddocks twice weekly or twice monthly. Pastures with IF were managed with twice monthly rotations. Generally, effects of year and forage management system x year did not affect ($P > 0.05$) calf performance. Actual weaning weight ($P = 0.083$), adjusted 205-d weaning weight ($P = 0.032$), total gain from birth to weaning ($P = 0.081$), and average daily gain from birth to weaning ($P = 0.028$) were greater or tended to be greater for calves raised on non-toxic forages (FF and OG) than for those raised on IF pastures; for actual weaning weights, this represented a 21-kg advantage for non-toxic pastures (OG and FF). Cows grazing OG and FF pastures exhibited higher ($P < 0.035$) bodyweights and body condition scores (BCS) at calving, breeding, and weaning than cows grazing IF pastures; however, BCS for cows grazing IF pastures remained acceptable (range = 6.1 to 6.7). Milk production in May for cows grazing nontoxic forages was greater than observed for cows grazing IF pastures (6.52 vs. 5.42 kg/d; $P = 0.011$), but this differential was not observed in July ($P = 0.587$). Serum prolactin levels also were greater for cows grazing non-toxic forages (181 vs. 90 ng/mL; $P = 0.005$) than for those grazing IF pastures. Conception rates did not differ ($P > 0.456$) among forage treatments (overall mean = 85.8%). Cow-calf performance was improved marginally by including non-toxic, perennial cool season grasses in bermudagrass pastures, but establishment costs

and additional management requirements may limit the acceptability of this approach.

Key Words: Tall Fescue, Orchardgrass, Cow-Calf Performance

59 Using orchardgrass and endophyte-free fescue versus endophyte-infected fescue overseeded on bermudagrass for cow herds: four-year summary of forage characteristics. W. K. Coblenz*, K. P. Coffey, D. A. Scarbrough, T. F. Smith, K. F. Harrison, D. S. Hubbell, III, B. C. McGinley, J. E. Turner, and J. B. Humphry, *University of Arkansas, Fayetteville.*

A four-year trial was initiated in January 2000 to evaluate forage production, basal cover, and persistence of endophyte-infected tall fescue (IF; *Festuca arundinacea* Schreb.), endophyte-free tall fescue (FF), or orchardgrass (OG; *Dactylis glomerata* L.) overseeded into dormant common bermudagrass [*Cynodon dactylon* (L.) Pers.] for spring-calving cows. The FF and OG pastures were managed with either a twice weekly (HM) or twice monthly (LM) rotation schedule, while the IF pastures were managed with a LM rotation schedule only. Forage-related response variables were evaluated with a split-plot design, where forage

system (IF-LM, FF-HM, FF-LM, OG-HM, and OG-LM) was the whole-plot term and sampling/evaluation date was analyzed as a repeated measure. Forage availability (four-year mean = 3809 kg/ha) was not affected ($P = 0.601$) by forage management system, but was affected by sampling date ($P < 0.0001$) and the forage system \times sampling date interaction ($P = 0.010$). Total basal cover varied ($P < 0.0001$) with sampling date, ranging from 36.3 to 51.5%, but was not affected by forage system ($P = 0.679$) or the interaction of main effects ($P = 0.354$). The interaction of forage system and evaluation date affected ($P = 0.038$) the percentage of the desired cool-season species in each pasture. Generally, FF and IF remained relatively stable over the entire study, ranging from 49.2 to 72.5% for FF-HM, 54.0 to 73.5% for FF-LM, and 46.9 to 65.8% for IF. However, the percentage of OG declined markedly ($P < 0.1$) since June 2002 in both the HM and LM grazing systems, ending at 36.2 and 14.7%, respectively, on the final (November 2003) evaluation date. After four years, FF has persisted well, but OG stands have thinned markedly, particularly under the LM rotation schedule. Therefore, FF may be a better choice than OG as an alternative to IF for spring-calving cow herds in the Upper South.

Key Words: Tall Fescue, Orchardgrass, Bermudagrass

National ADSA Foods Only (Graduate): ADSA Dairy Foods Graduate Paper Contest

60 Influence of pre-exposure of mycobacterium avium sub sp paratuberculosis to different environments on invasion of bovine epithelial cells in in vitro cell culture system. D. A. Patel*¹, L. Meunier-Goddik¹, and L. Bermudez², ¹*Food Science and Technology, Oregon State University, Corvallis,* ²*Department of Biomedical Sciences, Oregon State University, Corvallis.*

Mycobacterium avium sub sp paratuberculosis (MAP) is a causative agent of Johnes disease (JD) in cattle having significant economic impact. It is known that after crossing the mucosal barrier, MAP can disseminate and infection can spread to various sites including mammary gland. MAP can be exposed to high osmolarity and the intracellular environment of mammary gland epithelial cells. To study the influence of the environment on MAP invasion of bovine epithelial cells; MAP strain ATCC 19698 was used in the study. Immortalized MDBK (Madin Darby Bovine Kidney) cells were used as a model of bovine epithelial mucosa. MAC-T cells (mammary epithelial cells) were used for intracellular passage of MAP. MAP culture was inoculated in to raw milk, water and Middlebrook 7H9 broth (7H9 broth) containing Mycobactin J and OADC (10 % V/V) at 37 °C in the presence of antibiotics. MAP was also used to infect MAC-T cells for 1d and 4d at 37°C. MAC-T were then lysed and bacteria separated from host cell by differential centrifugation at 4 °C. MAP exposed to several environments was then added to polarized MDBK cells for 2hr. The percentage MAP invasion was calculated as percent of MAP inoculum that internalized in to MDBK cells. Statistical significance was determined by students t test and ANOVA. Our results indicated that MAP invasion is not significantly different at 1d among milk, broth and water preexposed samples. However, MAP passage in MAC-T cells significantly increased invasion percent (15 fold at 1d, p-value < 0.001 and 10 fold at 4d, p-value < 0.001) compared to control. Employment of RNA subtraction hybridization will help to define which MAP genes are associated with the invasive phenotype. These results indicate that exposure of intracellular MAP significantly increases its invasion efficiency for bovine epithelial cells. This characteristic may be important in establishing successful infection in susceptible host.

Key Words: Mycobacterium avium sub sp paratuberculosis, Invasion Assay, Mammary Epithelial Cells

61 Elucidation of the role of chymosin-mediated proteolysis in texture development during Cheddar cheese ripening. J. A. O'Mahony*^{1,2}, J. A. Lucey², and P. L. H. McSweeney¹, ¹*Department of Food and Nutritional Sciences, University College, Cork, Ireland,* ²*Department of Food Science, University of Wisconsin, Madison.*

More than 20 years ago, it was hypothesized that proteolysis of α_{s1} -casein by residual chymosin, early in ripening, is responsible for the initial softening observed in Cheddar cheese. To investigate this hypothesis, full-fat, Cheddar cheeses (2 kg) were manufactured with 0.1, 1.0 or 10.0 μmol pepstatin (a potent inhibitor of chymosin) added per litre of

curd/whey mixture at the start of cooking to obtain residual chymosin levels of 89, 55 and 16% of the activity in the control cheese, respectively. Texture profile analysis of cheeses was performed by compression (2 cycles) to 25% of original height. Levels of intact α_{s1} - and β -caseins were measured by densitometric analysis of urea-polyacrylamide gel electrophoretograms of pH 4.6-insoluble fractions from the cheeses. During the first 21 d of ripening, the rate of development of pH 4.6-soluble nitrogen (expressed as % of total nitrogen) was 0.29, 0.14, 0.06 and 0.04 %/d for control cheese and cheeses made with 0.1, 1.0 or 10.0 $\mu\text{mol L}^{-1}$ pepstatin, respectively. Concurrently, the level of intact α_{s1} -casein decreased by 49, 25, 7 and 3% in these cheeses. At 21 d of ripening, there was a significant ($P < 0.001$) reduction in hardness (maximum force on first compression cycle) in each of the 4 cheeses with initial (1 d) hardness values of 189, 204, 207 and 233 N decreasing to 115, 139, 163 and 187 N, in cheeses made with 0.0 (control), 0.1, 1.0 or 10.0 $\mu\text{mol L}^{-1}$ pepstatin, respectively. It was concluded that, irrespective of the extent of α_{s1} -casein hydrolysis, there was a significant softening of Cheddar cheese texture during the first 21 d of ripening and it appears that the hydrolysis of α_{s1} -casein by chymosin is not a prerequisite for Cheddar cheese softening. We believe that some physicochemical change(s), such as a reduction in the amount of calcium associated with the *para*-casein matrix of the curd may be responsible for this textural change.

Key Words: Proteolysis, Texture, Cheddar Cheese

62 Compositional factors associated with calcium lactate crystal formation in naturally smoked Cheddar cheese. P. Rajbhandari* and P. S. Kindstedt, *University of Vermont, Burlington.*

We have observed a high incidence of surface crystals among retail samples of naturally smoked Cheddar cheese. We have also occasionally observed that some samples displayed crystals whereas others originating from the same vat of cheese did not. This study compared the compositions of naturally smoked Cheddar cheese samples that contained surface crystals (Cry+) with those of samples originating from the same vat that were crystal-free (Cry-). Six pairs of retail samples (Cry+ and Cry-) produced at the same cheese plant on different days were obtained from a commercial source. Each pair was 5-6 mo old upon receipt and was stored for up to 18 mo at 4°C to insure that the Cry- sample remained crystal-free. Then, the crystalline material was scraped off the surfaces of Cry+ samples and analyzed for lactic acid, Ca, P, moisture and CP. Cry+ and Cry- samples were then sectioned into 3 concentric subsamples (0-5mm, 6-10mm and > 10mm depth from the surface) and analyzed for pH, TA, TS, NaCl, total and water-soluble Ca and P, and CP. The data were analyzed by ANOVA according to a repeated measures design with 2 within-subjects variables. The crystalline material contained 52.9% lactate, 8.1% Ca, 0.1% P, 28.5% water and 8.9% CP on average. Both Cry+ and Cry- cheese samples contained significant gradients of decreasing moisture from center to surface. Compared to Cry- samples, Cry+ samples possessed significantly higher moisture,

TA, water-soluble Ca and P, and significantly lower salt, pH and total Ca. The data suggest that within-vat variation in salting efficacy may have influenced calcium lactate crystal formation. Lower salt uptake by Cry+ cheese curd during salting may have resulted in higher moisture (and thus lactose) retention, which caused more lactic acid to be produced in the cheese. Higher lactic acid resulted in lower pH, which shifted calcium to the soluble state. Lactate and soluble Ca in Cry+ cheese became further elevated at the cheese surface as a result of dehydration during natural smoking, possibly triggering the formation of calcium lactate crystals.

Key Words: Cheddar, Calcium Lactate, Crystals

63 Influence of calcium, phosphorus, residual lactose, and salt-to-moisture ratio on cheese quality: pH changes during ripening. P. Upreti*, P. S. Lehtola, and L. E. Metzger, *Department of Food Science and Nutrition, MN-SD Dairy Food Research Center, University of Minnesota, St. Paul.*

The pH of cheese is an important attribute that influences its quality. Large changes in cheese pH are often observed during ripening. Changes in cheese pH during early ripening are associated with calcium (Ca), phosphorus (P), residual lactose, and salt-to-moisture ratio (S/M) of the cheese. Ca and P have the ability to act as a buffer that stabilizes cheese pH, whereas lactose is converted to lactic acid that causes a decrease in cheese pH. The S/M can influence bacterial growth that can affect the rate of conversion of lactose to lactic acid. The net balance between the buffering capacity and the formation of lactic acid should, therefore, determine cheese pH. In order to assess this hypothesis, 4 treatments of Cheddar cheese with 2 levels (high and low) of calcium (Ca) and phosphorus (P), and 2 levels (high and low) of residual lactose were manufactured. Each treatment was subsequently split in half and salted at 2 levels (high and low) for a total of 8 treatments. The detailed experimental design and manufacture of these cheeses is a subject of another abstract submitted for this conference. All the cheeses were salted at a pH of 5.4, pressed for 5h, and then ripened at 6-8°C. The pH of the salted curds before pressing, cheese at day 1, and weeks 1, 2, 3, and 4 of ripening was measured. The cheeses with low levels of Ca and P, high lactose, and low S/M showed a considerable drop in pH (mean=0.20 units) from salting to d1 of ripening, whereas, cheeses with high levels of Ca and P, low lactose, and high S/M showed an average drop in pH of 0.07 units. The comparison of pH of cheeses at 4wk indicated that cheeses with higher levels of Ca and P had higher pH ($p<0.05$) as compared to lower Ca and P cheeses. Also, cheeses with higher S/M were

higher in pH ($p<0.05$) as compared to lower S/M cheeses. Residual lactose content of cheeses had a significant effect ($p<0.05$) on cheeses at low salt content. However, at high salt content the effect of residual lactose was not significant. This study determined that changes in cheese pH during early ripening were influenced by Ca and P, lactose, and S/M.

64 Effect of starter inoculation rates and incubation temperatures on physical properties of yogurt. W. J. Lee* and J. A. Lucey, *Department of Food Science, University of Wisconsin, Madison.*

Textural attributes are considered as important criteria for the quality of yogurt. The objectives of this research were to investigate the effect of different starter culture inoculation rates and incubation temperatures on physical properties and microstructure of yogurt gels. A two factor (5×2) experimental design was used for data analysis. Yogurt gels were made with 0.5, 1, 2, 3, or 4% (w/w) inoculation rates and incubated at 40 or 46°C. Dynamic low amplitude oscillatory rheology was performed to monitor rheological properties of yogurt gels. Gel permeability and amount of surface whey were determined. Confocal scanning laser microscopy was used to examine gel structure. Storage modulus values (stiffness) increased with increased inoculation rate and decreased incubation temperature. Gels made at higher inoculation rate and incubation temperature exhibited higher yield stress and had higher loss tangent values (ratio of viscous to elastic moduli) during gelation, respectively. Higher permeability and whey separation values were observed in yogurt gels made at lower inoculation rate and higher incubation temperature, which indicated an increased susceptibility of the network to rearrange. These rearrangements resulted in the formation of large pores in gel network. An increase in inoculation rate resulted in a decrease in the pH where the maximum in loss tangent occurred, presumably reflecting less efficient solubilization of colloidal calcium phosphate (which is a slow process) and the need to attain a lower pH to complete the solubilization. Whey separation was positively correlated with the value for maximum in loss tangent ($r = 0.94$) and permeability ($r = 0.89$), respectively. A negative correlation was observed between whey separation and storage modulus ($r = -0.48$). It was concluded that rearrangements of casein particles in gel network and pH at which the solubilization of colloidal calcium phosphate occurred were important driving forces involved in whey separation and a weak network.

Key Words: Yogurt, Rheology, Starter Culture

National ADSA Production Only (Graduate)

65 Cloning the genomic sequence and proximal promoter of bovine pyruvate carboxylase. S. M. Rodriguez*, C. A. Bidwell, and S. S. Donkin, *Purdue University, West Lafayette, IN.*

Pyruvate carboxylase (PC) catalyzes a pivotal reaction in gluconeogenesis and lipid metabolism in liver. We previously identified six unique alternative splice variants in the 5 untranslated region (UTR) of PC mRNA. These splice variants may have a role in translational regulation of PC protein abundance. The objectives of this experiment were to clone and sequence the bovine PC gene, to determine the intron/exon organization of the 5UTR and to identify PC promoter elements. The RPCI-42 Bovine Bacterial Artificial Chromosome (BAC) library was screened with oligonucleotide sequences corresponding to specific elements of the 5 UTR sequence of bovine PC and to a region of the coding sequence. Two BACs that hybridized to all probes were selected for further analysis. A partial restriction map of the BACs was made with oligonucleotides corresponding to the coding region and the 89 and 110 bp elements of bovine PC 5 UTR. The BAC fragments that hybridized to the oligonucleotide probes were isolated and sequenced. The sizes of the cloned genomic PC 5 UTR fragments were verified by PCR, using genomic DNA from four cows. Sequencing data confirms the existence of a 178 bp exon that contains the 68 and 110 bp sequence elements of the 5 UTR for PC mRNA. The 178 bp exon appears to be the first transcribed exon in PC and the 68 and 110 bp 5 UTR sequences are most likely generated by alternative transcription start sites. Genomic sequence data also confirms that the 3 end of the 89 bp element is a discrete 41 bp exon. Regions within the genomic sequence adjacent to the 178 and 41 bp exons of the PC 5 UTR contain binding sites for TBP, Sp1, Ap1 and/or CEBP transcription factors. These data provide

information about the arrangement of exons in the 5 UTR of PC and about putative promoter regions.

Key Words: Pyruvate Carboxylase Gene, Liver, Promoter

66 Relationship between antibiotic susceptibility of mastitis pathogens and treatment outcomes. F. Hoe* and P. Ruegg, *University of Wisconsin, Madison.*

Antimicrobial susceptibility testing is commonly used to guide mastitis treatments. Broth microdilution is used to obtain quantitative results that are recorded as minimum inhibitory concentrations (MIC). The objective of this study was to determine the relationship between MIC values of mastitis pathogens and clinical outcomes. Duplicate quarter milk samples were obtained from cows observed with mild to moderate mastitis in a single quarter. Cows were ineligible if they had secondary clinical signs or had received antibiotics within the previous 30 days. Cows were treated with intramammary pirlimycin and could not receive ancillary treatments. Milk samples were collected before treatment and 14 and 21 days after treatment. Microbiological procedures were as described by the NMC. MIC values were determined using a commercial microdilution method (Sensititre, Westlake, OH). Of eligible milk samples ($n = 217$), 58 samples were no growth, 17 produced different growth on the duplicates and 6 were contaminated. MICs were obtained for: Strep spp. (34.6%); E.coli (25.7%); CNS (19.1%); Klebsiella spp. (9.6%) and other minor pathogens (14.0%). No significant difference was observed for days of treatment (2.8 and 2.9) and days until clinical cure (3.5 and 3.8) for gram positive and gram negative isolates, respectively

($P > 0.09$). No significant difference was observed for days of treatment (2.8 and 2.9) and days until clinical cure (3.4 and 3.8) for isolates that were susceptible or resistant to pirlimycin, respectively ($P > 0.9$). No significant differences in bacteriological cures were observed for gram positive (40.9% and 50.7%) and gram negative (50% and 50.9%) isolates, at day 14 and 21, respectively ($P > 0.8$). No significant differences in bacteriological cures were observed at day 14 (41.2% and 47.8%) or day 21 (50.9% and 50.7%) for susceptible or resistant isolates, respectively ($P > 0.7$). There was no association between farm and mean MIC for any antibiotic included in the mastitis susceptibility panel. This study did not identify an association between results of susceptibility testing and clinical outcomes of mastitis.

Key Words: Mastitis, Treatment, Susceptibility

67 Effect of selection for milk yield on hepatic prolactin receptor (PRLR) mRNA in Holstein cows. M. Carriquiry*, S. H. Wu, W. J. Weber, H. Chester-Jones, L. B. Hansen, and B. A. Crooker, *University of Minnesota, St. Paul.*

Prolactin participates in regulation of liver metabolic function, promotion of hepatocyte proliferation, and induction of growth related gene expression. Cows from control (stable milk yield since 1964; C) and select (S) genetic lines that differed in milk yield by more than 4,500 kg/305 d in milk (DIM) were used to evaluate effects of selection on hepatic mRNA for long (L-PRLR) and short (S-PRLR) isoforms of PRLR. Lines were fed ad libitum and exposed to the same environment. Multiparous (CM, SM) and primiparous (CP, SP) cows ($n = 8$ per line \times parity) blocked by calving date were biopsied at -12, 20, and 68 DIM. Hepatic RNA was isolated and L-PRLR and S-PRLR mRNA determined by real-time PCR. The same forward primer (5'-GCAGTGGCTTTGAAGGGCTATA-3') was used for each isoform. The reverse primer (5'-ACAAGGCGAGAAGGCTGTGATAT-3') for S-PRLR bound within the 39 bp insert specific for the S-PRLR isoform while the L-PRLR reverse primer (5'-GACTTGCCTTCTCCAGCAGAT-3') spanned the point (nucleotide 942) of this insert. Gene expression relative to hypoxanthine phosphoribosyltransferase (HPRT) was reported as relative units (ru). Results from a repeated measures analysis (PROC MIXED of SAS) differed when $P < 0.05$. Milk yields of CP, CM, SP, and SM cows were 18.6, 29.1, 29.6, and 48.6 kg/d. HPRT decreased as DIM increased primarily due to a lower expression in SP and CP at 68 DIM. L-PRLR (8.00b, 15.28a, 14.77a \pm 1.28 ru) and S-PRLR (5.24b, 8.07a, 8.45a \pm 0.72 ru) were less at -12 than at 20 or 68 DIM. There was a line by parity interaction for L-PRLR as mRNA in SM was greater than SP, CM and CP cows (21.00a, 11.57b, 8.82b, 9.35b \pm 1.85 ru). Select cows had more mRNA for L-PRLR (16.28, 9.08 \pm 1.31 ru) and S-PRLR (8.64, 5.87 \pm 0.74 ru) than control cows. The ratio L-PRLR to S-PRLR did not differ by DIM for control (1.88, 1.60, 1.55 \pm 0.16) but increased in select cows postpartum (1.46a, 2.12b, 1.95b \pm 0.16). Data suggest liver expression of L-PRLR is associated with increased milk yield.

Key Words: Genetic Selection, Liver, Prolactin Receptor

68 Exposure to short day photoperiod enhances mammary growth during the dry period of dairy cows. E. H. Wall*¹, T. L. Auchtung², G. E. Dahl², and T. B. McFadden¹, ¹University of Vermont, Burlington, ²University of Illinois, Urbana.

Exposure to short day photoperiod (SDPP; 8h light:16h dark) during the dry period increases milk yield of cows in the subsequent lactation. We hypothesized that this effect is due to increased growth of mammary epithelial cells in response to enhanced prolactin signaling converging on the IGF axis. Multiparous Holstein cows were dried off 62 days before parturition and assigned to long day (LDPP; 16h light:8h dark) or SDPP during the dry period. Mammary biopsies were obtained at -40, -20, -7 and +7 days relative to calving ($n=6$ cows/treatment) and rates of [³H]-thymidine incorporation into DNA *in vitro* were quantified. IGF-1, -2, and IGFBP-5 mRNA expression was assessed by real time RT-PCR. The mixed procedure of SAS was used for statistical analysis. For both treatments, cell proliferation rate increased from 40d to 7d ($P < .01$), then decreased in lactation ($P < .001$). However, timing of the proliferative response differed between treatments ($P < .05$). Proliferation rate increased from 40d to 20d in SDPP cows ($P < .01$) and was higher than LDPP cows at 20d ($P < .01$). The increase in proliferation did not occur until -7d for LDPP cows ($P < .01$). IGF-2 expression increased at -7d for SDPP cows ($P < .05$) and remained high in lactation, but did not increase in LDPP cows until after parturition ($P < .05$). IGFBP-5 mRNA

increased during lactation in both groups ($P < .05$) but was higher overall in LDPP cows vs. SDPP cows ($P < .05$). Expression of IGF-1 did not differ over time or between treatments. We conclude that exposure to SDPP during the dry period elicits earlier mammary cell proliferation relative to LDPP. Despite the lack of treatment difference in IGF-1 expression, lower IGFBP-5 expression in SDPP cows may increase IGF-1 availability to support mammary cell growth and survival. Temporal differences between treatments suggest the existence of a critical window wherein photoperiod affects mammary gland development during the dry period.

Key Words: Photoperiod, Mammary Growth, Prolactin Axis

69 Nutrient status influences the effect of conjugated linoleic acid on milk synthesis. M. J. de Veth*¹, E. Castaneda-Gutierrez¹, D. A. Dwyer¹, A. M. Pfeiffer², D. E. Putnam³, and D. E. Bauman¹, ¹Cornell University, Ithaca, NY, ²BASF-AG, Ofenbach, Germany, ³Balchem Encapsulates, New Hampton, NY.

The *trans*-10, *cis*-12 conjugated linoleic acid (CLA) isomer inhibits milk fat synthesis, whilst milk yield and synthesis of other milk components generally remains unchanged in cows in established lactation. However, in some CLA studies increases in milk yield and/or milk protein yield have been observed in cows limited in energy, either in early lactation or when fed pasture. Our objective was to evaluate the milk response to CLA when cows were provided limited dietary energy in combination with adequate or excess protein. Holstein cows ($n = 48$ mid-lactation) were fed ad-lib a TMR diet that met energy and protein requirements for a 16-d adjustment interval. Based on performance during this interval, the Cornell Net Carbohydrate and Protein System (CNCPS) model was used to design an energy-limiting ration that provided 80% of metabolizable energy requirement, which was fed to the experimental cows throughout the treatment periods. Cows were randomly allocated to four treatments (2 \times 2 factorial), in a 2 period crossover design. Treatments were: 1) protein adequate ration (PAR), 2) PAR + CLA, 3) protein excess ration (PER), and 4) PER + CLA. PAR and PER were set at 88% and 117%, respectively, of the metabolizable protein requirement established during the 16-d adjustment interval as estimated by the CNCPS model. Each experimental period comprised 16-d, with crossover of CLA within each level of protein. The dietary supplement of CLA was a lipid-encapsulated form that provided 12 g/d *trans*-10, *cis*-12 CLA. Milk samples were collected on the last 5d of each period. CLA treatment reduced milk fat yield (20.8%, $P < 0.01$), but increased both milk yield and milk protein yield (2.5% and 2.8%, respectively; $P < 0.05$). Milk yield, content and yield of both milk protein and milk fat were unaltered by either protein treatment alone or in combination with CLA. Overall, results demonstrate that CLA supplementation when cows are energy-limited may allow for increases in yield of milk and milk protein, and this may occur without the need for additional dietary protein.

Key Words: Conjugated Linoleic Acid, Milk Fat Depression, Milk Protein

70 Effect of transition diet on metabolism of Holstein cows in the periparturient period. J. Guo*, R. Peters, E. Russek-Cohen, and R. Kohn, *University of Maryland, College Park.*

The objectives were to characterize the homeorhetic change in blood metabolites and to evaluate the effect of transition diet on ketone body accumulation in periparturient cows. Twenty-eight multiparous Holstein cows were listed in order of their anticipated due dates and assigned to one of two groups with or without transition diet. The cows in treatment group received a transition diet (1.67 Mcal/kg NEL, 17% CP, 31% NDF) from 14 d before expected parturition to 14 d after calving and were fed the same diets as the cows in control group during the rest of experiment period. The cows in control group received a dry diet (1.38 Mcal/kg NEL, 11% CP, 53% NDF) from 28 d before expected due date, and a lactation diet (1.72 Mcal/kg NEL, 17% CP, 26% NDF) after parturition. Blood from coccygeal vein was sampled three times per week from 21 d before expected parturition to 21 d postpartum for analysis of glucose, non-esterified fatty acid (NEFA), β -hydroxybutyrate (BHBA), acetoacetate (ACAC), acetone, and glycerol. Plasma levels of ketone bodies changed in parallel, after parturition ketone bodies peaked at d 7 postpartum, and then decreased but remained high compared to values during the dry period. Plasma levels of NEFA and glycerol peaked at d 3 postpartum and changed in a similar pattern to those of ketone

bodies. Plasma glucose concentrations were higher for cows fed the transition diet compared with control cows in the last week prepartum (65.2 vs 55.1 mg/dl $P < 0.01$). Areas under the curve across the first 21 days postpartum for ACAC, NEFA, and glycerol were greater for cows receiving transition diets than for control cows ($P < 0.05$). There were no significant differences ($P > 0.05$) in peak plasma concentration (Cmax) and time of its occurrence (Tmax) between the treatment and control groups for glucose, NEFA, glycerol, acetone, ACAC, and BHBA. Results indicate that plasma glycerol may be an important contributor to gluconeogenesis during the periparturient period. Feeding a transition diet had a negative impact on postpartum metabolic variables.

Key Words: Transition Diet, Ketone Bodies, Fat Mobilization

71 The effect of copper supplementation and breed on milk fatty acid profile. J. Sumner^{*1} and P. French², ¹Washington State University, Pullman, ²Oregon State University, Corvallis.

An experiment was conducted to determine the effect of dietary copper (Cu) on Cu status and lipid metabolism in Holstein and Jersey cattle. Eight Jersey and 8 Holstein cows in mid-lactation (169 ± 37) were blocked by days in milk and assigned at random to one of two diets. Cows received either a control diet (Cu-) which contained a basal level of 8 mg Cu/kg DM or a treatment (Cu+) diet that was supplemented with 16 mg Cu/kg DM from CuSO₄ for a total of 24 mg Cu/kg DM. As expected, DM intake and milk yield were greater for Holsteins and milk fat and protein percentages were greater for Jerseys. Plasma Cu was greater for Jerseys and hepatic Cu was greater at 90 days of treatment for Cu+ Jerseys compared to Cu+ Holsteins. Total C18:0 in milk was lower for both Cu+ treatment groups. On day 90 of treatment, conjugated linoleic acid (CLA) in milk was less for Cu+ compared to Cu-. Also on treatment day 90, Cu+ cows produced more total saturated fatty acids than Cu- cows for both breeds. These results indicate that Cu metabolism differs between these two breeds. In addition, Cu supplementation decreased CLA secretion possibly due to an effect on biohydrogenation in the rumen or stearyl coenzyme A desaturase, an enzyme involved in the production of CLA.

Key Words: Copper, CLA

72 Evaluation of the ability of dietary fish oil to maintain elevated conjugated linoleic acid (CLA) in milk from dairy cows through five months of lactation. M. T. Sands*, S. T. Franklin, J. A. Jackson, L. J. Driedger, and K. I. Meek, University of Kentucky, Lexington.

Most trials for enhancement of milk CLA by dietary means have been short-term. The objective of this study was to determine the long-term ability of dietary Menhaden fish oil to maintain elevated CLA in milk fat of dairy cows. Nine primiparous cows (3 Jersey and 6 Holstein) and 12 multiparous cows (3 Jersey and 9 Holstein) were blocked by breed and parity and assigned to dietary treatments. Lactating diets were 1) control (CON), 2) cottonseed (CS), or 3) fish oil (FO) at 1.5% of dry matter (DM). During the dry period, cows assigned to the CON and CS diets were fed a dry cow control diet (DCON) and cows assigned to the FO diet were fed a dry cow diet containing 0.5% FO (DFO). Cows were housed in a free stall barn with Calan head gates approximately 4 wk prepartum to allow for 1 wk of acclimation and 3 wk of data collection. Postpartum feed intake and milk yields were recorded daily. Weekly milk samples were analyzed for fat, protein, and somatic cell count (SCC). Milk was sampled weekly for the first 2 wk and then biweekly for fatty acid analysis. Body condition scores (BCS) were estimated monthly and cows were weighed weekly throughout the trial. Serum was collected weekly through wk 4, then biweekly for analysis of nonesterified fatty acids (NEFA) and β -hydroxybutyrate (BHBA). Cows fed CON consumed more ($P < 0.05$) DM compared with cows fed CS and FO diets (21.6 ± 1.5 , 17.5 ± 1.5 , and 15.4 ± 1.5 kg/d respectively). Milk and protein yield were not affected ($P > 0.05$) by diet but fat yield was lower for cows fed FO. Both CLA and TVA were elevated ($P < 0.05$) in milk from cows fed FO compared with milk from cows fed CON or CS. Mean CLA content was $1.9 \pm 0.1\%$ in milk from cows fed FO compared with $0.6 \pm 0.1\%$ in milk from cows fed CON and CS. Dry cow DM intake, NEFA, BHBA, body weight, BCS and SCC were not affected by diet. Results indicate that cows fed FO at 1.5% of DM through 5 mo of lactation were able to maintain elevated concentrations of CLA and TVA

without adverse effects on serum NEFA, serum BHBA, body weight, or BCS.

Key Words: Fish Oil, Conjugated Linoleic Acid, Dairy

73 Effects of dietary CLA on production parameters in pasture-fed transition dairy cows. J. K. Kay^{*1,2}, J. R. Roche^{2,3}, and L. H. Baumgard^{1,3}, ¹University of Arizona, Tucson, ²Dexel, New Zealand.

High dietary CLA doses inhibit milk fat synthesis in TMR-fed dairy cows by wk 2 of lactation, however, CLA effects on pasture-fed cows immediately post-partum have not been investigated. Multiparous Holstein cows ($n=39$) grazing pasture were randomly assigned to one of three treatments: 1) pasture (PAS), 2) PAS + 600 g/d rumen protected (RP) CLA (RP-CLA) and 3) PAS + 540 g/d Hyprofat (RP palm oil; HF). RP-CLA and HF treatments were isoenergetic, fed 2x/d and provided 197 and 0 g CLA/d, respectively. Treatments began 14-21 d pre-partum and continued until 36 DIM. Milk was sampled on d 1, 2, 3 and 4 post-partum and every third d (± 1) until d 36, and fatty acid composition was determined on d 4, 8 and 15 (± 2). There was no overall RP-CLA effect on protein content (3.78%) or protein or lactose yield, however RP-CLA increased ($P < 0.01$) overall milk lactose content (4.90%) compared to HF (4.75%), but did not differ from PAS (4.82%). RP-CLA reduced ($P < 0.05$) milk fat content by 6 DIM (4.16, 5.69 and 4.98% for RP-CLA, PAS and HF, respectively) and continued to inhibit milk fat synthesis as DIM progressed, with maximum ($\sim 40\%$) milk fat depression (MFD) occurring by d 21. Milk fat yield followed a similar temporal pattern although differences did not occur until d 15. There was no overall treatment effect on milk yield (20.3 kg/d), however a quadratic relationship ($R^2=0.6$) was detected between the RP-CLA induced milk yield response and extent of MFD in RP-CLA vs. HF. RP-CLA tended to increase milk yield (1.5 kg/d; $P=0.08$) until MFD exceeded 30%, after which point the increase in milk yield declined. Milk fat *trans*-10, *cis*-12 CLA content averaged 2.4 mg/g in the RP-CLA treatment, was undetectable in PAS and HF treatments and did not differ over time. RP-CLA did not affect the Δ^9 -desaturase system nor did it alter the origin of fatty acids (*de novo* vs. preformed; molar basis) until d 15. These data indicate a high RP-CLA dose decreases milk fat synthesis and tends to increase milk yield immediately post-partum in pasture-fed cows, however excessive MFD ($>30\%$) is associated with a diminished milk yield response.

Key Words: CLA, Pasture, Transition Period

74 Effect of feeding Ca salts of palm oil (PO) or of a blend of linoleic and monoenoic trans fatty acids (LTFA) on lactation and health of Holstein cows. S. O. Juchem^{*1}, R. L. A. Cerri¹, M. Villasenor¹, K. N. Galvao¹, R. G. S. Bruno¹, H. M. Rutigliano¹, A. C. Coscioni¹, E. J. DePeters¹, W. W. Thatcher², D. Luchini³, and J. E. P. Santos¹, ¹University of California, Davis, ²University of Florida, Gainesville, ³Bioproducts, Inc., Fairlawn, OH.

Holstein cows, 511, were blocked according to parity, BCS at dry off and previous lactation milk production and randomly assigned to receive (2% diet DM) either Ca salts of PO or LTFA from 23 d prepartum to 70 d in milk (DIM). Yields of milk and milk components were measured weekly, and BCS was evaluated at -43, -23, calving, and at 40, 70, 100 and 140 DIM. Blood was sampled weekly from 23 d prepartum to 21 DIM, and plasma was analyzed for glucose, NEFA and BHBA. Fatty acid profile in milk fat was analyzed at 2 and 10 wk postpartum in 30 cows/treatment. Disease incidence was recorded for individual cows. Continuous and binomial data were analyzed by the MIXED and LOGISTIC procedures of the SAS (2001), respectively. Interval from calving to an event (death, culled, disease) was analyzed by the LIFETEST procedure of SAS (2001). Yields of milk were similar for LTFA and PO (38.4 vs 38.9 kg/d; $P=0.32$). However, feeding LTFA reduced 3.5% fat-corrected milk (36.8 vs 39.1 kg/d) because of a decrease in milk fat % (3.3 vs 3.6%; $P < 0.05$) resulting in lower milk fat yield (1.24 vs 1.37 kg/d; $P < 0.01$). The negative effect on milk fat was observed after the second week of lactation. Milk protein % was increased by feeding LTFA (2.78 vs 2.74; $P < 0.01$), but milk protein yield (1.06 vs 1.06 kg/d) and SCC were similar ($P > 0.15$). Feeding LTFA increased ($P < 0.01$) the concentrations of linoleic acid (3.56 vs 2.83%), C18:1 trans 10 (1.0 vs 0.4 %), C18:1 trans 11 (1.5 vs 1.0%) and CLA cis 9, trans 11 (0.8 vs 0.5%) in milk fat on week 10 postpartum, but differences were already detected at wk 2 postpartum. BCS did not differ ($P > 0.15$) between LTFA and PO

at -43d (3.77 vs 3.80), calving (3.68 vs 3.67), 100 DIM (2.78 vs 2.79). Feeding LTFA compared to PO had no effect on incidence of clinical ketosis (8.2 vs 6.9%), displacement abomasum (3.1 vs 1.6%), and milk fever (1.9 vs 2.0%). Cows fed LTFA had reduced yields of fat and 3.5%

FCM, altered milk fatty acid profile, but changes in FCM yield did not reflect in positive effects on BCS or health. Supported by NRI/USDA Grant 2003-02742.

Key Words: Fatty Acids, Dairy Cows, Trans Fatty Acids

Horse Species

75 Insulin resistance in growing Thoroughbreds is affected by diet. K. Treiber^{*1}, R. Boston², D. Kronfeld¹, R. Hoffman¹, W. Staniar¹, and P. Harris³, ¹*Department of Animal and Poultry Sciences, Virginia Polytechnic Institute and State University, Blacksburg,* ²*Department of Clinical Studies, New Bolton Center, Kennett Square, PA,* ³*Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton-Mowbray, UK.*

Insulin resistance is associated with obesity and inactivity and may be a risk factor for metabolic disorder in horses. This study applied the minimal model to test the affect of diet on glucose and insulin in young horses. Twelve Thoroughbred foals were raised on pasture and supplemented twice daily with a feed high in either sugar and starch or fat and fiber. As weanlings (age 199 ± 19 d, weight 274 ± 18 kg) the subjects underwent a modified frequently sampled intravenous glucose tolerance test during which they remained in stalls and had access to grass hay and water ad libitum. Samples were collected at -60, -45, 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 19, 22, 23, 24, 25, 27, 30, 35, 40, 50, 60, 70, 80, 90, 100, 120, 150, 180, 210, 240, 270, 300, 330 and 360 min with a glucose bolus of 300 mg/kg BW at 0 min and an insulin bolus of 1.5 mU/kg BW at 20 min. Plasma was analyzed for glucose and insulin. Insulin sensitivity (SI), glucose effectiveness, acute insulin response to glucose (AIRg) and disposition index were derived using Minmod Millennium and WinSAAM software. Diets were compared using the non-parametric Kruskal-Wallis test and the sign test. Basal glucose did not differ between groups (P = 0.75). Insulin levels were higher in the sugar and starch adapted weanlings at all 36 sample points (P = 0.030). The fasting glucose:insulin ratio for the sugar and starch supplemented weanlings was lower than for fat and fiber weanlings (P = 0.025). Insulin sensitivity was lower in weanlings fed sugar and starch than weanlings fed fat and fiber (P = 0.007). Acute insulin response to glucose was inversely correlated with SI (r = -0.54; P = 0.068). The glucose:insulin ratio was directly correlated to SI (r = 0.63; P = 0.036). These results show that weanlings adapted to a supplement high in sugar and starch had lower insulin sensitivity compared to weanlings adapted to a fat and fiber feed. Weanlings adapted to sugar and starch appeared to compensate for a lower sensitivity to insulin by increasing insulin secretion. Feeding meals high in glucose equivalents may increase the risk of developing insulin resistance and associated disorders in horses.

Key Words: Horse, Insulin Resistance, Minimal Model

76 Somatotropic axis in growing Thoroughbreds is affected by diet. K. Treiber^{*1}, W. Staniar¹, D. Kronfeld¹, R. Boston², and P. Harris³, ¹*Department of Animal and Poultry Sciences, Virginia Polytechnic Institute and State University, Blacksburg,* ²*Department of Clinical Studies, New Bolton Center, Kennett Square, PA,* ³*Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton-Mowbray, UK.*

The somatotropic axis comprises a network of metabolites and hormones that link nutrition to growth. Feeds high in glucose equivalents cause exaggerated fluctuations in components of this network and may contribute to metabolic and growth disorders. This study analyzed samples from a frequently sampled intravenous glucose tolerance test (FSIGT) to determine the effect of diet on plasma concentrations of insulin, growth hormone (GH) and insulin-like growth factor-I (IGF-I) in growing horses. Twelve Thoroughbred foals were raised on pasture and supplemented twice daily with a feed high in either sugar and starch (SS) or fat and fiber (FF). As weanlings (age 199 ± 19 d, weight 274 ± 18 kg) the subjects underwent an FSIGT during which they remained in stalls and had access to grass hay and water ad libitum. Samples were collected at -60, -45, 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 19, 22, 23, 24, 25, 27, 30, 35, 40, 50, 60, 70, 80, 90, 100, 120, 150, 180, 210, 240, 270, 300, 330 and 360 min with a glucose bolus of 300 mg/kg BW at 0 min and an insulin bolus of 1.5 mU/kg BW at 20 min. The minimal model was used to estimate insulin sensitivity (Si). Plasma was analyzed for

glucose, insulin, GH and IGF-I concentrations. Feed groups were compared using the non-parametric Kruskal-Wallis test. Time interactions for IGF-I were compared by ANOVA with repeated measures. Robust linear regression was used for correlations. Growth hormone concentrations were increased from basal 19 to 180 min after the glucose dose (P < 0.05). Basal IGF-I was higher (P = 0.006) in the SS group compared to the FF group. Concentrations of IGF-I increased with time (P = 0.002) in the SS group. Basal IGF-I was inversely correlated to SI (-r = 0.52; P = 0.10). These results show that weanlings adapted to meals high in glucose equivalents have higher IGF-I secretion as compared to weanlings adapted to a fat and fiber supplement. This deviation may be associated with insulin resistance and metabolic dysfunction in horses fed concentrates high in hydrolyzable carbohydrates.

Key Words: Diet, Growth Hormone, Insulin-Like Growth Factor-I

77 Environmental factors and nutrient composition of pasture in northern Virginia. T. A. Cubitt^{*}, W. B. Staniar, and D. S. Kronfeld, *Department of Animal and Poultry Science, Virginia Polytechnic Institute and State University, Blacksburg.*

Greater than 90% of horses in Virginia receive all or part of their nutrition from pasture (USDA/APHIS, 1988). The objective of this study was to test for association between environmental factors and pasture variables, and to compare equine requirements for growth and reproduction, as recommended by the NRC (1989), to nutrient content determined by proximate analysis of pasture samples taken at monthly intervals for 5 y in northern Virginia. Day length (DL, h) and temperature (T, C) were measured. Statistical analysis included Pearson correlations, linear regressions and quadratic curves (SAS, 2000). Significant associations were found between DL and CP (r = -0.16, P = 0.02), ADF (r = 0.24, P = 0.0004), and NSC (r = -0.15, P = 0.04). Temperature significantly correlated with DM (r = 0.76, P = 0.0001), CP (r = -0.23, P = 0.0007), ADF (r = 0.32, P < 0.0001), and NSC (r = -0.19, P = 0.004). A quadratic relationship was fit between CP and T with an R² = 0.20, P < 0.0001. A linear regression fit to ADG (kg/d) versus CP resulted in an R² = 0.11, P < 0.0001. The data was adjusted for the delay in change in ADG as compared to CP, to give a clearer indication of the strength of the association and the resulting R² = 0.23, P < 0.0001. In comparison to the requirements for growth and reproduction the pastures tested were deficient in Zn, Cu and P. Crude protein was above the requirements set by the NRC (1989). This study presents a temporal relationship between environmental factors, nutrients in the pasture, and growth variables. We suggest that certain minerals are below the recommended minimums listed in the NRC for horses at certain times of year. This data is useful in developing sound management practices for horses raised on pasture.

Key Words: Nutrient Requirements, Horses, Pasture

78 The effects of age, breed, gender and use on gastric ulceration in the horse. K. Chamero^{*}, J. Nadeau, S. Bushmich, J. Dinger, and T. Hoagland, *University of Connecticut, Storrs.*

Gastric ulceration in horses has been identified as a serious health concern. The goal of this study was to determine if there was an effect on the occurrence of ulcers among a genetically diverse population of horses composed of several different ages, breeds, gender, and use. Eighty horses ranging in age from 2 years to 23 years were used. Their breeds consisted of Morgans, Quarter horses, Warmbloods, Thoroughbreds, and grade horses. Mares and geldings were included. All horses were used in one of three different capacities: polo, lessons, or training. Horses were examined by endoscopic examination, visible ulcers were scored according to an accepted gastric ulcer scoring system. Comparisons of the distribution of the occurrence of ulcers, lesion number, and lesion severity scores were made with chi square analyses using an expected occurrence of 30% based on two previous studies. Nine of the 80 horses

(11%) had ulcers located in the nonglandular squamous epithelial mucosa. The mathematical mean of the lesion number score was 2.22 and the mathematical mean of the lesion severity score was 2.67. For all age groups, the occurrence of ulcers was not different than expected. Occurrence of ulcers was not different in Morgans, Quarter horses, and Warmbloods. Thoroughbreds and grade horses had fewer ($P < 0.05$) ulcers than expected. The occurrence of ulcers among all breeds was lower ($P < 0.01$) than expected. Geldings had fewer ($P < 0.01$) ulcers than expected, while the occurrence of ulcers was not different than expected in mares. The occurrence of ulcers for both genders was lower ($P < 0.01$) than expected. Occurrence of ulcers was less than expected in horses used in lessons ($P < 0.01$) and in polo ($P < 0.05$). The occurrence of ulcers was not different in horses in training. For all three use categories, the occurrence of ulcers was lower ($P < 0.01$) than expected. Among all categories, lesion number and lesion severity was not different than expected. Since overall percent and occurrence of ulcers in this population was lower than in previous studies, it may be suggested that such things as management practices, length of turnout, and overall contact may play an important role in the occurrence of ulcers.

Key Words: Gastric Ulcers, Horse, Breed

79 Evaluation of feeding bee pollen to horses in training. K. K. Turner*, B. D. Nielsen, C. I. O'Connor, and J. L. Burton, *Michigan State University, East Lansing.*

"Bee pollen" is often fed to horses but few studies have evaluated its use. Our hypothesis was feeding bee pollen would positively influence nutrient digestibility, and indices of immunological status and physical fitness in horses in training. Ten Arabians (6 geldings, 4 mares) underwent a standardized exercise test (SET). Horses were pair-matched by sex and fitness and randomly assigned to P (receiving 118 g of bee pollen (Dynamic Trio 50/50) daily) or C (control receiving 73 g of a placebo) for a supplementation period of 42 d. A total collection period was conducted on geldings from d 18 to 21 to determine effects of bee pollen on nutrient retention and digestibility of NDF and ADF. Horses were exercise conditioned during the 42-d trial and completed another SET on d 42. V_{160} and V_{200} were calculated from SET heart rates (HR). Lactate, glucose, hematocrit (HT) and hemoglobin (HB) concentrations were determined from SET blood samples. Total and percent leukocytes, T and B lymphocytes, monocytes, neutrophils, and eosinophils, as well as IgG, IgM and IgA concentrations were determined from rest and recovery samples from both SETs. Geldings in P ate more feed than C on every day of the collection period. P had 80 % less phosphorus excretion ($P = 0.003$), and tended to retain 90 % more nitrogen ($P = 0.08$). P tended to digest more NDF ($P = 0.06$) and ADF ($P = 0.09$). P had lower NDF digestibility ($P = 0.002$) and tended to have lower ADF digestibility ($P = 0.07$). Although no treatment differences existed, V_{160} and V_{200} increased ($P < 0.05$), and HR ($P = 0.002$), blood lactate concentration ($P < 0.0001$), HT ($P < 0.0001$) and HB ($P = 0.0003$) decreased from d 0 to 42. Few treatment differences were seen in immunological parameters. There was a trend for percent monocytes to increase in C while decreasing in P ($P = 0.1$) from rest to recovery on d 42. Percent

Milk Protein and Enzymes

81 Composition of the air interface in ice cream as affected by protein and emulsifier content. Z. Zhang* and D. Goff, *Department of Food Science, University of Guelph, Guelph, ON, Canada.*

Emulsifiers and proteins interact during the production of ice cream to form the fat interface, which in turn controls the extent of partial coalescence and hence fat structure formation in the frozen product. The interaction of these ingredients at the air interface, however, has not been as well investigated. We have examined the effect of saturated or unsaturated mono-glyceride and the effect of protein from skim milk powder or whey protein isolate on the composition of the air interface by immuno-gold labeling and transmission electron microscopy. When ice cream was made from skim milk powder in the absence of emulsifier, casein micelles, non-micellar b-casein and b-lactoglobulin were found at the air interface. When emulsifiers were used, more fat was seen at the air interface, especially with unsaturated mono-glyceride. When whey protein isolate was used, fat globules were seldom found at the air interface, regardless of emulsifier presence. As the fat interface is formed

neutrophils increased from rest to recovery on d 42, with P increasing more ($P = 0.04$). Percent neutrophils was increased on d 42, compared to d 0, with the greatest increase in P ($P = 0.04$). Bee pollen supplementation, while not affecting measured fitness variables, may have a positive effect on performance by helping meet increased metabolic demands of equine athletes by increasing nutrient retention and feed intake.

Key Words: Pollen, Horse, Exercise

80 Potassium supplementation affects plasma $[K^+]$ during an 80 km endurance exercise test on the treadmill. T. M. Hess*¹, K. Treiber¹, D. S. Kronfeld¹, J. N. Waldron², C. A. Williams¹, M. S. Freire¹, A. M. G. B. Silva¹, L. S. Gay¹, D. A. Ward¹, and P. A. Harris³, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Rectortown Equine Center, Rectortown, VA, ³Equine Studies Group, Waltham Centre for Pet Nutrition, Melton-Mowbray, UK.

During exercise plasma $[K^+]$ increases and can lead to increased neuromuscular excitability and related clinical signs. Supplementation of K during exercise can further increase plasma $[K^+]$. A K-free electrolyte mixture (EM-K) was tested and compared to a K-rich mixture (EM+K) during an 80 km simulated endurance exercise test (EET) on a treadmill. Twelve horses were tested in a cross over design performing four bouts (B) of 20 km at 45% of their maximum heart rates with three 30-minutes of rest (R) between bouts. Before the start of EET and during each R horses were supplied with EM-K or EM+K. Blood samples were collected before (PRE), at 10 km of each B, at 20 minutes of every R and 10 minutes after B4 (REC) and analyzed for hematocrit (Hct), and plasma for pH, PCO_2 , lactate ($[La^-]$), phosphate ($[PO_4^-]$), albumin (alb), CK and AST and electrolytes. Horses were weighed and electrocardiograms done at PRE, every R, and REC; weights were also measured in the morning after (MA) EET. Effects of stage (PRE, B1, B2, B3, B4, R1, R2, R3, R4, REC, MA) treatment (EM-K vs EM+K) and their interactions were evaluated by ANOVA in a mixed model with repeated measures. Body weight losses during EET increased up to 4.96% at REC, and were 2.3% below PRE at MA ($P < 0.001$). Hct increased during B, returned to PRE at every R ($P < 0.001$). Plasma alb increased during EET ($P < 0.001$), returning to PRE values at REC. Plasma CK and AST increased progressively during EET ($P < 0.001$). Plasma pH increased with exercise, decreased with R and REC ($P < 0.001$). Plasma PCO_2 and $[Ca^{++}]$ decreased during exercise and increased during R periods, however $[Ca^{++}]$ was lower than PRE at REC ($P < 0.001$). Plasma $[Mg^{++}]$ decreased initially with exercise, but then was higher than PRE at REC ($P < 0.001$). Plasma $[Na^+]$, $[Cl^-]$, $[La^-]$, and PO_4^- increased progressively during the EET ($P < 0.0001$). No abnormalities were observed on the EKG results. A treatment effect was found for plasma $[K^+]$ ($P = 0.014$), where horses that received EM-K had lower values than EM+K. Lower plasma $[K^+]$ during exercise could help maintain resting membrane potential and prevent signs of neuromuscular hyperexcitability.

Key Words: Potassium, Equine, Exercise

first during ice cream processing, the composition of the air interface was found to be a direct consequence of the composition of the fat interface.

Key Words: Milk Proteins, Air Interface, Immuno-Labeling

82 Evidence that the major novel disulfide bond in heated cows milk is between β -lactoglobulin Cys160 and κ -casein Cys88. E. K. Lowe¹, S. G. Anema^{1,2}, M. J. Boland¹, R. Jiménez-Flores³, and L. K. Creamer*¹, ¹Fonterra Research Centre, Palmerston North, New Zealand, ²Riddet Centre, Massey University, Palmerston North, New Zealand, ³Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo.

Heat treatment of milk causes the milk proteins to interact irreversibly with one another, primarily caused by disulfide bond interchange. Early studies have shown that heating β -lactoglobulin (BLG) in solution invokes Cys-mediated disulfide bond interchange to give BLG polymers and BLG molecules with non-native disulfide bonds. Some of these molecules and polymers contain Cys66 or Cys160 in the reduced state.

It has long been known that both BLG and κ -casein (KCN) are present in the complexes formed as a consequence of heat treatment. BLG contains five Cys residues and KCN contains 2 Cys residues, and thus there is a large number of combinations of possible disulfide bondings. Reacting reduced KCN with DTNB (dithiobisnitrobenzoic acid) gives KCN molecules containing activated Cys groups. Reacting partially reduced BLG with these derivatives gave a range of products. These were separated and the fraction that contained material with a mass of about 35 kDa was hydrolyzed with trypsin. Among the products were peptides with masses corresponding to the peptides BLG148-162 SS KCN87-97 and BLG148-162 SS KCN11-16. The identity of the peptides was verified by partial sequencing of both the intact peptides and the reduced peptides using ESI-MS-MS. A heated milk sample was analyzed and these peptides were identified in a trypsin-treated sample of the mixture of proteins and there was significantly more disulfide-bonded KCN87-97 than KCN11-16 in the mixture. The existence of other possible disulfide bonding patterns involving Cys 66, 106, 119, or 121 of BLG, and Cys 11 or 88 of KCN are being explored.

Key Words: Heat-Induced Complex, Whey Protein, Casein

83 Application of novel gel electrophoresis to analyze native, heat-, and pressure-treated milk protein systems. H. A. Patel^{1,2}, H. Singh³, and L. K. Creamer^{*1}, ¹Fonterra Research Centre, Palmerston North, New Zealand, ²Institute of Nutrition, Food and Human Health, Massey University, Palmerston North, New Zealand, ³Riddet Centre, Massey University, Palmerston North, New Zealand.

The invention of gel electrophoresis presaged great advances in all protein sciences and has been particularly useful in dairy protein science. Incorporation of urea into the gels allowed clear separation of the caseins from one another and reduction of the disulfide bonds allowed the clarification of the polypeptides that comprise the native α_{s2} - or κ -casein (KCN). Addition of other solutes, such as magnesium chloride or SDS, meant that the basis of separation could be changed. The advent of two-dimensional electrophoresis in polyacrylamide gels gave even greater power because the two separations could be under very different conditions; for example, the alkaline urea PAGE followed by SDS PAGE. The best-known 2D method uses isoelectric focussing followed by SDS PAGE, is very powerful technique and is used extensively in proteomics research. Our group has been using electrophoresis to study some particular problems, such as: Does β -lactoglobulin (BLG) bind preferentially to α_{s2} -CN or KCN during heat treatment carried out in non-native conditions? In the whey protein scene, 2D PAGE as modified by our group allowed the identification of the pathways leading to BLG and whey protein aggregation and gelation during heat treatment. These techniques, with some added

Nonruminant Nutrition: Finishing Pigs - Additives & Energy

85 Effect of L-lysine-HCl addition in late finishing gilts fed ractopamine HCl (Paylean®). B. W. Ratliff^{*1}, A. M. Gaines¹, P. Srichana¹, G. L. Allee¹, and J. L. Ustry², ¹University of Missouri, Columbia, ²Ajinomoto Heartland LLC, Chicago, IL.

The objective of this 21 d experiment was to evaluate the effect of L-lysine-HCl addition on growth performance of pigs fed ractopamine HCl (Paylean®). A total of 966 gilts (TR-4 × C22; 98.2 ± 0.2 kg) were randomly allotted to one of six dietary treatments with seven replicate pens/treatment and 23 pigs/pen. Dietary treatments included five levels of L-lysine-HCl that corresponded to concentrations of 0.10, 0.20, 0.30, 0.40, and 0.50% lysine, respectively. With the exception of L-threonine and Alimet® feed supplement (88% L-methionine activity), additional synthetic amino acids were not supplied to meet the minimum amino acid profile. To evaluate the effect of maintaining a minimum amino acid profile, additional synthetic amino acids (L-tryptophan, L-isoleucine, and L-valine) were supplemented to a diet containing 0.50% L-lysine-HCl. All diets were corn-soybean meal-based with 2% choice white grease formulated at a 0.93% TID lysine and contained 7 ppm Paylean®. Increasing the L-lysine-HCl inclusion resulted in a decrease (quadratic, P < 0.04) in ADG (1,016, 1,016, 1,016, 1,043, and 966 g/day, respectively) and lowered (quadratic, P < 0.02) G:F (0.352, 0.357, 0.353, 0.352, and 0.338, respectively). There were no differences (P = 0.40) in ADFI. Use of two slope-broken line analysis indicated a maximum L-lysine-HCl inclusion of 0.41% for ADG and 0.39% for G:F. The addition of synthetic amino acids to the diet containing 0.50% L-lysine-HCl did not restore growth performance. Collectively, these data demonstrate

refinements, have now been applied to a range of dairy protein problems of varying complexity. For example, the examination of heat and pressure treated milks which has led to an even greater clarification of the relative roles of α_{s2} -CN or KCN in their reaction with the aggregating whey proteins

Key Words: PAGE Analysis, Protein-Protein Interaction, Caseins and Whey Proteins

84 Effects of genetic modification, pressure, and heat on the binding of various probes to β -lactoglobulin. K. A. N. S. Ariyaratne¹, G. B. Jameson¹, T. S. Loo², G. E. Norris², H. A. Patel^{4,3}, T. Considine^{4,5}, H. Singh⁵, L. K. Creamer^{*4}, and R. Jiménez-Flores⁶, ¹Institute of Fundamental Sciences, Massey University, Palmerston North, New Zealand, ²Institute of Molecular Biosciences, Massey University, Palmerston North, New Zealand, ³Institute of Nutrition, Food and Human Health Massey University, Palmerston North, New Zealand, ⁴Fonterra Research Centre, Palmerston North, New Zealand, ⁵Riddet Centre, Palmerston North, New Zealand, ⁶Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo.

Native β -lactoglobulin (BLG) has been shown to bind a number of hydrophobic and amphipathic molecules within the central calyx. Examples are: hexane, retinol (vitamin A), cholesterol, 12 bromo-dodecanoic acid, palmitic acid, and cis-parinaric acid (CPA) but not anilino-naphthalene sulfonate (ANS). The binding of retinol and CPA can be followed by induced circular dichroism or increased fluorescence. This has allowed the determination of the displacement of CPA or retinol by dodecyl sulfate (SDS) or palmitate, but not by ANS. Heat treatment denatures the BLG, and the binding of CPA and retinol decreases in proportion with the extent of denaturation while ANS fluorescence increases. Pressure treatment has a similar effect. Addition of these ligands of BLG increases the stability of the protein under increased temperature and pressure. ANS does not have this effect. Polynucleotides were synthesized and expressed to give fusion proteins, corresponding to both the A and B variants of BLG. These were subsequently cleaved to obtain synthetic BLG A and BLG B. Modification of the polynucleotide allowed the preparation of a number of different BLG mutants. Some of these were modifications close to the binding site of retinol and the fatty acids. In particular the change of lysine to glutamic acid at residues 60 and 69 showed dramatic differences in behavior. These two residues are close spatially but the change at residue 60 prevents binding of retinol or CPA while that at residue 69 does not.

Key Words: Lactoglobulin Binding, Mutant Protein, Pressure Treatment

that up to 0.40% L-lysine-HCl can be added in Paylean® diets without compromising growth performance, provided the diets are supplemented with L-threonine and a methionine source. Furthermore, maintaining a minimum amino acid profile in Paylean® diets containing 0.50% L-lysine-HCl does not restore growth performance indicating that another nutrient may be limiting.

Key Words: Ractopamine, Lysine, Pigs

86 Threonine to lysine ratio in ractopamine treated pigs. D. M. Fernandez^{*1}, N. Rosas², A. I. Soria¹, and J. A. Cuarón³, ¹Universidad Nacional Autónoma de México, ²Patronato de Apoyo a la Investigación y Experimentación Pecuaria en México A.C. Queretaro, MX, ³Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias Queretaro, MX.

Previously we titrated the digestible lysine requirement of finishing pigs in the presence or absence of 5 ppm ractopamine (RAC). The objective of this study was to determine the threonine to lysine ratio (T:L, %) required to maximize growth performance of finishing pigs fed diets containing either 5 or 10 ppm RAC. One hundred individually penned crossbred pigs (Landrace × Duroc) were used in a 28-d trial. Initial body weight averaged 77.2 ± 4.04. Dietary treatments included 1) a control diet (CON) formulated to .67% digestible lysine (DL) and 3.20 Mcal

ME/kg (T:L=70), 2) As 1 + 5ppm RAC (T:L=70), 3) CON supplemented with L-lysine-HCl to .82% DL and L-threonine to .47% digestible threonine (DT), and 5 ppm RAC (T:L=57), 4) As 3 + .041% DT (T:L=62); 5) As 3 + .082% DT (T:L=67), 6) As 3 plus .123% DT (T:L=72), 7) CON supplemented with L-lysine-HCl to .92% DL and L-threonine to .53% DT, and 10 ppm RAC (T:L=57), 8) As 7 + .046% DT (T:L=62), 9) As 7 + .092% DT (T:L=67), and 10) As 7 + .138% DT (T:L=72). The experiment was conducted as a randomized complete block design with 10 replicates per treatment. Pigs were fed ad libitum twice a day and voluntary feed intake (FI) was measured. Pigs were weighed at d0, d7, d14, d21 and d28. Backfat depth, muscle depth, and loin eye area were measured between the 10th and last rib 6.5 cm off the midline using real-time ultrasound at d0, d14, and d28 to calculate fat-free-lean gain (FFLG). Diets with RAC decreased FI (P<.11), but most of the effect was due to the 10 ppm dose (2.69, 10 ppm vs. 2.88 kg/d at 5 ppm). The T:L ratio at 5ppm RAC showed a quadratic effect (P<.01) in ADG: .79, .95, .90 and .77 kg/d for the 57 to 72% T:L ratio. From these data the best T:L ratio was calculated at 64% (range of 62 to 67%). The RAC effect was evident (P<.01) in FFLG and primal cuts. The RAC response in FFLG and primal cuts to the T:L ratio was only detected at 5 ppm. At 10 ppm, FFLG and primal cuts were higher in CON compared to RAC at all T:L levels.

Key Words: Pigs, Threonine, Ractopamine

87 Effects of increasing total sulfur amino acid:Lys on performance and carcass characteristics of gilts fed a ractopamine step-up program. A. Yager*, L. Wilson, K. Sadoris, L. Peddireddi, R. Hinson, M. Walsh, D. Sholly, B. Richert, A. Schinckel, and J. Radcliffe, *Purdue University, West Lafayette, IN.*

One hundred eighty crossbred (Dekalb 45 x EB) gilts (initial BW = 80 kg) were used in a 5-wk study to determine the effects of increasing total sulfur amino acid to Lys ratio (TSAA:Lys) in ractopamine fed pigs. Gilts were blocked by BW and randomly assigned to diets within block (6 pens/diet). Diets met or exceeded all nutrient requirements (NRC, 1998) except true ileal digestible (TID) TSAA. Dietary treatments were fed across two phases (P1, d 1-18; P2, d 18-35). Diets 1-4 contained 1.03/0.93% (P1/P2) TID Lys, 5/10 ppm ractopamine, and TID TSAA:Lys of 0.52, 0.57, 0.62, and 0.67, respectively. Diet 5 (control), contained TSAA:Lys of 0.67 similar to diet 4, but with lower inclusion of Lys-HCl (0.10 vs. 0.30%) and L-Thr (0.08 vs. 0.17%). Individual BW and pen feed intake were recorded on d 0, 9, 18, 27, and 35. Last and 10th rib backfat (BF) and loin eye area (LEA) were determined ultrasonically (4 pigs/pen) at d 0, 18, and 35. Gilts were harvested at the end of the experiment (BW = 117 kg), and carcass ultrasound fat depth, loin depth, and % lean estimates were recorded. The TSAA:Lys had no effects (P > 0.10) on overall ADG or G:F. Pigs fed higher levels of synthetic AA (diet 4 vs. 5) consumed less feed (P < 0.05) during P2 and overall. During P2, G:F tended to improve as TSAA:Lys increased, except for pigs fed a TSAA:Lys of 0.62, which decreased G:F (quadratic, P < 0.10). Tenth rib LEA increased to a TSAA:Lys of 0.62 (quadratic, P < 0.05) during P1, but the 0.62 ratio had the smallest increase during P2. Overall change in 10th rib LEA increased (linear, P < 0.10) 15.7, 16.3, 17, and 18 cm² as TSAA:Lys increased. TSAA:Lys had no effect (P < 0.10) on live ultrasound 10th rib BF thickness, carcass ultrasound fat depth, loin depth, or estimated carcass lean. Carcass ultrasound fat depth decreased (P < 0.05) and loin depth increased (P < 0.05) for pigs fed diet 4 compared to diet 5. Increasing the TSAA:Lys had minimal effects on growth and carcass traits. However, using increased TID TSAA:Lys and synthetic amino acids may improve ADFI and carcass ultrasound fat and loin depth estimates.

Key Words: Pig, Amino Acid Ratio, Growth

88 Efficacy of SUPROL[®] as a growth promotant for grow-finish pigs. R. C. Thaler*¹, B. D. Rops¹, B. T. Christopherson², and E. Cerchiani³, ¹*South Dakota State University, Brookings*, ²*SODA Feed Ingredients LLC, Brookings, SD*, ³*SODA Feed Ingredients Ltd., IRL.*

One hundred high lean-gain barrows weighing approximately 20 kg were utilized in a grow-finish trial to determine the efficacy of SUPROL[®] as a growth promotant. SUPROL[®] is a microencapsulated mixture of organic acids and essential oils that is used as a natural growth promotant. Five dietary treatments were used (Control (Con); Con + SUPROL[®]; Con + SUPROL[®] + BMD; Con + Tylan; Con + Mecadox) in a 4-phase

feeding program. There were 5 pigs/pen and 4 replicates/treatment. The trial was terminated at a final weight of 114 kg BW. From 20-36 kg (Grower 1), there were no differences (P>.05) in ADG, ADFI, or G/F. Midway through the Grower 1 phase, a mild PRRS outbreak occurred. However, it appeared all treatment groups were affected by it. For the Grower 2 phase (36-59 kg), pigs on the Mecadox or SUPROL[®] + BMD treatments consumed more feed (P<.05) than pigs fed the other dietary treatments, and pigs fed the SUPROL[®] or Con diets were more efficient (P<.05) than pigs fed the other 3 treatments. For the Finisher 1 (59-86 kg), and Finisher 2 (86-114 kg) periods, there were no differences in performance (P>.10). In the overall period from 20-114 kg BW, daily gain and feed intake were unaffected (P>.10) by treatment but feed efficiency was affected by treatment with the pigs fed the SUPROL[®] diets being the most efficient (P<.05). Based on these results, SUPROL[®] is an effective, natural feed additive that improves grow-finish pig performance.

Key Words: SUPROL[®], Organic Acids, Essential Oils

89 Effect of wheat sample, particle size and xylanase on energy digestibility of wheat fed to grower pigs. R. T. Zijlstra*¹, T. N. Nortey¹, D. Overend³, R. Hawkes¹, M. D. Drew², J. Fledderus⁴, J. F. Patience¹, and P. H. Simmins⁵, ¹*Prairie Swine Centre Inc., Saskatoon, SK, Canada*, ²*University of Saskatchewan, Saskatoon, SK, Canada*, ³*Ridley Inc., Mankato, MN*, ⁴*De Schothorst, Lelystad, The Netherlands*, ⁵*Danisco Animal Nutrition, Marlborough, UK.*

The DE content of wheat is variable, being caused by constraints in energy digestibility. These constraints may be reduced by feed processing, e.g., grinding and xylanase supplementation. The responses from three wheat samples (W1, high; W2, medium and W3, low DE; predicted using NDF, 20.1, 29.3, and 35.7% DM, respectively), at three particle sizes (fine, FPS; medium, MPS and coarse, CPS), to control or *Trichoderma* xylanase (2625 U/kg diet) on energy digestibility were studied in a 3 x 3 x 2 factorial arrangement. Pigs (54; 29.4 ± 2.4 kg) were fed two diets (96% wheat, 0.4% chromic oxide) each at 3-x maintenance in subsequent periods for 6 pigs per diet. Feed and feces were analyzed to determine apparent total-tract energy digestibility. Energy digestibility was affected by wheat sample, particle size, xylanase, sample x particle size, and sample x xylanase (P<0.01). Energy digestibilities were different for W1, W2 and W3 (P<0.001; 85.1, 77.4 and 76.7%, respectively) and confirmed the predicted DE ranking. Based on *in-vitro* analyses, starch in all three wheat samples was rapidly degradable (P > 0.10), indicating that NDF was not related to starch digestion. Overall, energy digestibility for FPS was 2.3 and 3.0% higher than for MPS and CPS (P<0.001; 81.1, 79.3 and 78.7%, respectively), and was 0.9% higher for xylanase than control (P<0.01). Xylanase improved energy digestibility 2.0% for W2 and 1.4% for W3 (P<0.01), but not for W1 (P>0.10), and FPS improved energy digestibility 4.8% for W2 and 3.8% for W3 compared to CPS (P<0.01), but not for W1 (P>0.10), together indicating that beneficial effects of processing depended on wheat sample. Prediction of wheat quality prior to processing and subsequent adjustments in processing may be components in a decision model to achieve consistent dietary DE content.

Key Words: Wheat, Particle size, Xylanase

90 Hydration properties of different cereal grains before and after enzymatic digestion as affected by thermal treatment and grinding. M. Anguita, E. Creus*, and J. F. Perez, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Physicochemical properties of feed structures are nutritionally relevant during their passage in the digestive tract. Amongst these properties, the hydration capacity has been extensively studied in relation with the gastrointestinal function and microbial composition. We measured water retention capacity (WRC; Table) of three cereals (wheat, barley and oats) as the amount of water retained after centrifugation (3,500 x g) by the insoluble substrate (g water/g incubated DM). The cereals were processed by hydrothermal cooking (100C; 60 min) or extrusion (75 rpm; 70 atm; 145C), and ground in a hammer mill (0.8 and 3.0 mm). The WRC was measured using an *in vitro* model, which simulates the gastric (pepsin; pH = 2.0; 4 h; Gastric WRC) and small intestine (SI) digestion [Pancreatine (pancreas extract); pH = 7.0; 4 h; SI WRC]. Average values of WRC were similar for Gastric and SI digestion of raw and cooked ingredients, suggesting that WRC may be mainly determined by the

content of insoluble and undigested substrate (IUS). The relationship between SI WRC and IUS was: $WRC = 0.0279 IUS + 0.7047$ ($R^2 = 0.654$). On the other hand, extrusion of cereals promoted a significant increase in Gastric WRC, probably due to the gelatinization and dispersion of starch. Extrusion and grinding promoted decreases in SI WRC, which was associated with a decrease on the amount of IUS rather than a variation on the feed particle size. Further studies are required *in vivo* to evaluate the influence of processing on the physicochemical properties of digesta and the gastrointestinal microbial population.

	Wheat		Barley		Oats	
	Gastric	SI	Gastric	SI	Gastric	SI
Raw						
0.8 mm	1.4	1.7	1.9	1.9	2.4	2.5
3.0 mm	1.6	1.8	2.4	2.4	3.2	3.1
Hydrothermal						
0.8 mm	1.4	1.2	1.9	1.7	1.8	2.2
3.0 mm	1.7	1.6	2.6	2.6	2.8	2.6
Extrusion						
0.8 mm	3.5	0.9	3.6	1.1	2.6	1.9
3.0 mm	3.8	1.0	3.6	1.2	2.8	2.1
SEM	0.10	0.05	0.04	0.10	0.16	0.12
Thermal	***	***	***	***	*	***
Grinding	**	0.08	***	***	***	***
Thermal*grinding	NS	NS	***	***	0.07	NS

Values are least square means; NS, $P > 0.05$; * $P < 0.05$
 ** $P < 0.01$; *** $P < 0.001$.

Key Words: Processing, Cereal, Water Retention

91 Response of growing and finishing pigs to dietary energy concentration. J. F. Patience^{*1}, A. D. Beaulieu¹, R. T. Zijlstra¹, and N. H. Williams², ¹*Prairie Swine Centre Inc., Saskatoon, SK, Canada*, ²*PIC USA, Inc., Franklin, KY*.

Achieving the full genetic potential for swine growth requires an understanding of the response to dietary energy in all phases of growth. This experiment was designed to develop an energy response curve for growing and finishing pigs. Barley and soymeal based diets were formulated with increasing wheat and canola oil to contain 3.05, 3.19, 3.33, 3.47, or 3.61 Mcal DE/kg. Separate diets were formulated with appropriate dLys:DE ratios for barrows and gilts within 3 phases of growth (25 to 50, 51 to 80 and 81 to 115 kg BW). Offspring of C22 females and L337 boars (n=300) were blocked according to gender, weight per day of age and BW and randomly assigned to treatment. Light (28.8 kg mean BW) and heavy (33.6 kg mean BW) blocks allowed the determination of differential animal response to energy according to initial weight. Pigs were weighed on d0, d14 and at the end of each phase. ADG averaged 0.97, 1.07 and 1.07 kg/d in phases 1, 2 and 3, respectively, and was unaffected by diet DE concentration ($P > 0.05$). Lighter pigs grew 50 g/d slower than heavier pigs ($P < 0.001$). Block by DE interactions did not exist ($P > 0.05$). Overall feed intake decreased from 2.76 to 2.49 kg/d (linear, $P < 0.001$) and feed efficiency improved from 0.36 to 0.42

Physiology and Endocrinology: Factors Affecting Embryonic and Fetal Mortality

95 Effect of elevated systemic concentrations of ammonia and urea on amino acid concentrations in oviduct fluid in cattle. D. A. Kenny^{*1}, P. G. Humpherson³, D. G. Morris², H. J. Leese³, M. G. Diskin², and J. M. Sreenan², ¹*Department of Animal Science and Production, Faculty of Agriculture and Food Science, University College, Dublin, Ireland*, ²*Teagasc Research Centre, Athenry, Co. Galway, Ireland*, ³*Department of Biology, University of York, York, UK*.

It has been suggested that elevated systemic concentrations of urea and ammonia may compromise early bovine embryo development in the oviduct. The objective of this study was to determine the effect of elevated systemic ammonia and urea on amino acid (AA) concentrations in cattle oviduct fluid. Heifers (n=25) were allocated to one of three intravenous infusion treatments; saline (C), urea (U) or ammonium chloride (AC) at either 2 or 8 d after oestrus. Treatment solutions were infused over a 7 h period and oviduct fluid was collected during mid

(linear, $P < 0.001$) as DE increased from 3.05 to 3.61 Mcal DE/kg. DE concentration did not affect lean thickness (average 61.3 mm; $P > 0.05$), however, backfat increased from 16.8 to 19.4 mm when DE increased from 3.05 to 3.61 Mcal/kg (linear, $P < 0.05$). In conclusion, a positive response to dietary energy concentration is confirmed for feed conversion, but not ADG. Further research is required to understand why pigs do not always respond to increased dietary energy concentration with improved growth.

Key Words: Swine, Energy, DE

92 Withdrawn by author. . .

93 Withdrawn by author. . .

94 Palm oil and hydrogenated fat as alternative oil sources for fattening pig diets. P. Medel^{*1}, J. I. Fernández², J. Peinado¹, J. C. González¹, and C. López-Bote⁴, ¹*Imasde Agropecuaria, S.L. Spain*, ²*Norel, S.A. Spain*, ³*Universidad Complutense de Madrid, Spain*.

A total of 96 Large White × Landrace*Large White pigs of 29.0 ± 3.2 kg of initial BW, 50 % males and females, were used to study the influence of type of fat source on productive performance and carcass quality. Feeding program consisted of three phases offered *ad libitum* (1.08 % lys from 29 to 63 kg BW, 1.03 % lys from 63 to 78 kg BW, and 0.89 % lys from 78 to slaughter at 96 kg BW). There were 4 treatments based on fat source (5 % of inclusion): T1 and T2, containing respectively lard or palm oil throughout the whole period, T3, containing soy oil from 29 to 63 kg and hydrogenated palm stearin thereafter, and T4, containing soy oil from 29 to 78 kg and hydrogenated palm stearin thereafter. Each treatment was replicated four times (12 pigs housed together), and biopsies from 2 pigs per pen were taken at every change of diet. For the whole period, feeding lard improved growth and feed conversion relative to T3, showing all the other dietary treatments intermediate results (754, 717, 670, 704 g/d and 2.56, 2.71, 2.76 and 2.70 g feed/g gain for T1 to T4, respectively, $P < 0.05$). Fatty acid profile (FAP) was similar for T1 and T2 and presented low variation throughout the trial, with T2 showing slightly higher values for palmitic and stearic acids at the end of the trial. From 63 kg or 78 to slaughter, palmitic, oleic and stearic acids were increased in T3 and T4, respectively, reaching the T1 and T2 range for palmitic acid, but showing higher stearic and lower content of oleic and linoleic acids than control diets. Type of fat did not affect dressing percentage, backfat depth, or carcass pH and temperature. It is concluded that: i) palm oil can be used efficiently as an alternative to lard, and ii) hydrogenated fats may be used to increase fatty acids positively related to fat consistency when unsaturated fat sources has been previously fed, but administration should begin at least at 60 kg and productive performance could be affected.

Key Words: Hydrogenated Fats, Fatty Acids, Fattening Pigs

ventral laparotomy over the final 3 h of infusion. Oviduct and blood plasma samples were analysed for concentrations of ammonia, urea and 17 AA. There was no treatment × day interaction for any of the plasma or oviduct fluid AA measured ($P > 0.05$). The concentration of all AA was similar between oviducts ipsi- or contralateral to the corpus luteum. Plasma and oviductal urea were elevated by infusion with U ($P < 0.001$) and AC ($P < 0.05$). Plasma and oviductal ammonia were elevated by AC ($P < 0.001$) but not by U ($P > 0.05$). There was no effect of day on plasma concentrations of any AA ($P > 0.05$). Plasma and oviductal glutamine, histidine and valine were similar ($P > 0.05$) while the concentration of all other AA was lower in plasma than oviduct fluid ($P < 0.01$). Plasma glutamine was higher in animals on AC than on C (0.29 ± 0.03 v 0.19 ± 0.03 ; $P < 0.05$) while plasma isoleucine was lower in animals on AC than on C (0.04 ± 0.008 v 0.06 ± 0.008 ; $P < 0.05$). There was no effect of infusion treatment on the plasma concentration of any of the other AA measured ($P > 0.05$). Across treatments, oviductal isoleucine was higher on day 2 than 8 (0.06 ± 0.004 v 0.05 ± 0.004 ; $P <$

0.05) and there was a tendency for oviductal concentrations of histidine and lysine ($P = 0.06$) and isoleucine and phenylalanine ($P = 0.07$) to be higher on day 2 than 8. These data, in combination with previous studies from this laboratory, show that elevated systemic concentrations of ammonia or urea *per se* are unlikely to reduce embryo survival in cattle, particularly through disruptions to the oviductal environment.

Key Words: Oviduct, Amino Acids, Urea

96 Initial characterization of abortigenic activity associated with mare reproductive loss syndrome. K. J. McDowell^{*1}, N. M. Williams¹, J. M. Donahue¹, M. D. Lindemann¹, K. E. Newman², and B. A. Webb¹, ¹University of Kentucky, Lexington, ²Venture Laboratories, Lexington, KY.

A newly recognized abortigenic disease, now known as mare reproductive loss syndrome (MRLS), struck the Ohio Valley in Spring, 2001. Abortion rates exceeded 60% on some farms, and epidemiological surveys (Dwyer et al., 2003, JAVMA 222:613-619) linked abortions with eastern tent caterpillars (ETC; *Malacosoma americanum*). Previous studies demonstrated that feeding mares ETC causes abortion, the abortigenic activity is stable to freezing but not autoclaving, it is not extracted with aqueous solutions, and is confined to the insect cuticle (Webb et al., 2004, J Insect Physiol 50:185-193). Therefore, these studies were designed to test the hypothesis that ETC abortigenic activity can be extracted with an organic solvent, and to determine if ETC produce lesions in animals that ingest them. Pregnant mares ($n = 5/\text{group}$) were fed ETC cuticle (+ control), corn oil (- control), ground cuticle, corn oil containing lipids extracted from cuticle with methylene chloride (MC), or cuticle after extraction (treatments were equivalent of 50g insect/mare/day for 10 days). Abortion rates were 3/5 ($P < 0.05$), 2/5, and 1/5 for mares fed cuticle only, cuticle after MC extraction, or ground cuticle. No mares fed MC extract or corn oil alone aborted. All abortions were typical of MRLS including increased echotexture of fetal fluids and presence of streptococci or actinobacilli in aborted fetuses. This study provides new information that the abortigenic activity does not reside in extractable lipids of the cuticle, and that disrupting physical integrity of the cuticle reduces the abortigenic activity. In subsequent trials, mares or gilts fed ETC had lesions containing ETC setae in the submucosal region of their GI tracts, while control animals fed the same diet had no lesions. These findings led to the hypothesis that ETC cuticular setae penetrate the intestinal lining and allow bacteria from the GI tract to invade the circulatory system. Fetal infections then lead to fetal death and abortion.

Key Words: Equine, Caterpillar, Abortion

97 Developmental competence of oocytes fertilized in vitro with semen from bulls grazing tall fescue pastures. G. M. Schuenemann^{*1}, J. L. Edwards¹, J. L. Lawrence¹, R. R. Payton¹, F. N. Scenna¹, J. C. Waller¹, J. W. Oliver², and F. N. Schrick¹, ¹Department of Animal Science, University of Tennessee, Knoxville, ²Department of Comparative Medicine, University of Tennessee, Knoxville.

During a two-year study, developmental competence of oocytes fertilized in vitro with semen of yearling beef bulls grazing Kentucky 31 tall fescue (*Festuca arundinacea* Schreb.) infected with *Neotyphodium coenophialum*, an ergot alkaloid-producing fungal endophyte (E+; $n = 3/\text{yr}$), or Jesup tall fescue infected with the non-ergot alkaloid-producing endophyte strain MaxQ#8482 (MaxQ; $n = 3/\text{yr}$) was determined. Bulls were grouped by scrotal circumference, BW, breed composites, and age to graze E+ or MaxQ pastures from November to July. Each year, semen was collected from the same bulls in May and June by electroejaculation. After motility and morphology examinations, semen was diluted with Bioxcell extender and maintained at 4°C until fertilization of oocytes (26 h after semen collection). Oocytes were matured for 22.5 h and fertilized with the identical number of motile percoll-prepared sperm for each treatment. Number of putative zygotes that cleaved and developed to blastocysts (including nuclei number) was evaluated on d 3 and 8 post-fertilization, respectively. Data were arranged in a randomized block design and analyzed using mixed models of SAS. Percent normal sperm morphology ($86.8 \pm 3.8\%$) recorded at time of collection did not differ between pasture types. Motility at semen collection (72.5 ± 7.2 and $75.4 \pm 6.5\%$), immediately prior to (48.7 ± 7.6 and $53.3 \pm 6.7\%$), and after (56.8 ± 5.4 and $59.9 \pm 5.9\%$) percoll preparation was not different between E+ and MaxQ treatments, respectively. Semen from E+ bulls decreased cleavage rates (73.5 ± 3.1 vs $84 \pm 2.4\%$; $P = 0.02$)

compared to MaxQ bulls. Development to 8-cell (85.4 ± 10.3 vs $82.3 \pm 8.7\%$), blastocysts (32.4 ± 5.5 vs $30.1 \pm 4.7\%$), and nuclei number (72.9 ± 4.8 vs $76.5 \pm 4.5\%$) of cleaved embryos did not differ between treatments. In conclusion, use of semen from bulls grazing tall fescue containing the ergot alkaloid-producing fungal endophyte decreased embryonic cleavage rates and may lower reproductive performance due to reduced fertilization ability.

Key Words: Tall Fescue, Bull, Fertility

98 The association between early luteal phase concentrations of progesterone and embryo survival in heifers and dairy cows. M. G. Diskin^{*1}, A. J. H. Stronge¹, D. G. Morris¹, D. A. Kenny², and J. M. Sreenan¹, ¹Teagasc Athenry, Co. Galway, Ireland, ²University College, Dublin, Ireland.

There is evidence of an association between systemic progesterone (P4) and embryo survival in cattle but not all studies are in agreement on the timing of this association. A retrospective analysis of two large-scale data sets was carried out to clarify the temporal associations between early luteal phase P4 and subsequent embryo survival for both beef heifers and dairy cows. In study 1 beef heifers ($n = 368$) were inseminated (day 0) by one inseminator using semen from one high fertility bull. Two blood samples were collected on day 7 (am and pm) and subsequently assayed (RIA) for P4. In study 2 milk samples were collected on days 5, 6 and 7 post AI from dairy cows in 6 herds (total inseminations=871). The concentration of P4 was measured by enzyme-immunoassay. In both studies pregnancy diagnosis was carried by ultrasonography at about 40 days post AI. Logistic regression was used to evaluate the relationship between the post insemination concentration of P4 and embryo survival rate. Sixty-eight and 48% of the inseminated animals in studies 1 and 2, respectively, were pregnant at 40 days post AI. In study 1 there was a positive linear ($P < 0.01$) and quadratic ($P < 0.01$) association between plasma P4 on day 7 and subsequent embryo survival rate. In study 2 there were positive linear and quadratic relationships ($P < 0.05$) between milk P4 on days 5, 6 and 7 and between the change in P4 between days 4-7 inclusive and embryo survival rate. This analysis indicates an optimum concentration of P4 during the early luteal phase above or below which embryo survival or conception rate is reduced.

Key Words: Progesterone, Embryo, Survival

99 Effect of ovulatory follicle size on pregnancy rates and fetal mortality in beef heifers. G. A. Perry^{*1,2}, M. F. Smith³, A. J. Roberts¹, M. D. MacNeil¹, and T. W. Geary¹, ¹USDA-ARS Miles City, MT, ²Department of Animal & Range Science, South Dakota State University, Brookings, ³Department of Animal Science, University of Missouri, Columbia.

Ovulatory follicle size at time of GnRH/TAI significantly influenced pregnancy rates and fetal mortality following timed AI (TAI) in postpartum cows. Our objective was to assess the relationships between ovulatory follicle size and pregnancy rates or fetal mortality in beef heifers bred in one of two breeding groups: 1) heifers ($n = 108$) were inseminated following the CO-Synch protocol (TAI), subsequently 2) heifers ($n = 154$) were inseminated after detection in standing estrus by electronic mount detectors during a 23-d breeding season (EAI). Transrectal ultrasonography was used to determine ovulatory follicle size at AI and pregnancy status on d 27, 41, 55, and 68 after TAI. The relationship between follicle size and pregnancy status was quadratic for both TAI ($P < 0.01$) and EAI ($P = 0.04$), indicating predicted maximum pregnancy rates of $69.3 \pm 5.8\%$ at a follicle size of 12.7 mm and $73.6 \pm 4.8\%$ at a follicle size of 13.3 mm, respectively. Interactions between breeding group and follicle size did not affect pregnancy rate or fetal mortality ($P > 0.20$). Pooled across breeding groups, the relationship between pregnancy rate and follicle size was quadratic ($P < 0.01$) and indicated an intermediate predicted maximum pregnancy rate of $71.2 \pm 3.8\%$ at a follicle size of 13.1 mm. Follicles < 11.5 mm or > 16 mm were less likely ($P < 0.05$) to support pregnancy than an optimal sized follicle (13.1 mm). Fetal mortality between d 27 and 68 was independent of follicle size ($P > 0.20$), but was only 2% in these data. Ovulation of smaller than optimal sized follicles are a more serious problem than ovulation of larger than optimal sized follicles, as 47% of heifers ovulated follicles #8804 11.5 mm but only 3% ovulated follicles > 16.0 mm. Ovulatory

follicle size is a strong indicator of fertility and management practices that influence ovulatory follicle size may significantly influence fertility.

Key Words: Follicle Size, Pregnancy Rates, Fetal Mortality

100 Follicular phase events and the postovulatory progesterone rise in dairy cows. G. Mann* and G. Starbuck, School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough, UK.

In dairy cows, the timing of the postovulatory progesterone rise is critical to early embryo development. The aim of this study was to determine how variation in the timing of follicular phase events contributes to the timing of the postovulatory progesterone rise. The study was performed on 18 mature, non-lactating Holstein-Friesian cows in which plasma concentrations of progesterone, oestradiol and LH and the timing of oestrus and ovulation were determined at 8h intervals following induction of luteolysis. Ovulation was determined through ultrasound scanning at 8h intervals commencing at the onset of oestrus. Four animals were excluded on the basis of abnormal reproductive function. The remaining 14 cows showed normal reproductive function with oestrus occurring 57.4 ± 4.5 h and the LH surge 58.2 ± 5.1 h following luteolysis (progesterone fall to <1 ng/ml). The LH surge was followed by a fall in circulating oestradiol concentration at 64.6 ± 4.4 h. Cows ovulated at 88.0 ± 4.7 h with the postovulatory progesterone rise (to >1 ng/ml) occurring 167.4 ± 7.2 h after luteolysis. Cows were split on the basis of interval from progesterone fall to progesterone rise giving groups with long (188.6 ± 6.7 h; $n=7$) and short (146.3 ± 5.7 h; $n=7$) intervals from luteolysis to post ovulatory progesterone rise. Both the interval from progesterone fall to ovulation (106.3 ± 6.9 h vs. 85.7 ± 3.4 h; $P < 0.05$) and the interval from ovulation to progesterone rise (82.3 ± 4.2 h vs. 60.6 ± 5.5 h; $P < 0.01$) were longer in long interval cows. While the time from onset of oestrus to progesterone rise was also longer in the long interval group (82.3 ± 4.2 h vs. 60.6 ± 5.5 h; $P < 0.01$) the time from oestrus to ovulation did not differ (long 27.4 ± 3.0 h vs. short 34.3 ± 3.4 h). Thus in cows with an extended period from luteolysis to the subsequent progesterone rise, a delay in the time from luteolysis to ovulation and a delay in the time from ovulation to the progesterone rise appear to contribute equally to the overall delay while the interval from oestrus to ovulation is similar to that seen in cows with a shorter interval. Supported by MAFF and MDC under the Link Sustainable Livestock Production Programme.

Key Words: Cow, Ovulation, Progesterone

101 Effect of hCG on d 5 of the estrous cycle on luteal function and pregnancy rates (PR) in lactating cows receiving embryos from gossypol fed donor heifers. K. N. Galvao*, A. C. Coscioni, S. O. Juchem, M. Villasenor, and J. E. P. Santos, University of California, Davis.

Objectives were to determine the effects of hCG treatment on day 5 of the estrous cycle on luteal function and PR in lactating cows receiving frozen/thawed embryos from gossypol fed donor heifers. Holstein cows, 269, were blocked by parity, days in milk (DIM) and body condition score (BCS) and randomly assigned to one of six treatments in a 2x3 factorial design. Recipient cows were treated with either hCG (3,300 IU) or kept as controls on d 5 and received an embryo on day 7 collected from heifers fed 0, 20, or 40 mg of free gossypol/kg of BW resulting in consumption of 0, 8, and 16 g/d of free gossypol. Recipients were synchronized with the Ovsynch protocol. Ovaries were examined by ultrasonography every injection of the Ovsynch, and at 2, 5 and 12 days after the last GnRH to determine ovulation, and size of follicles and CL. Pregnancy was diagnosed on gestation days 28 and 42 (21 and 35 d after embryo transfer). Data were analyzed by the LOGISTIC and GLM procedures of SAS (2001). Because fertility responses were similar for embryos from heifers fed 20 and 40 mg of free gossypol/kg of BW, data were combined. Treatment with hCG on d 5 increased the proportion of cows with an accessory CL on day 12 (92.6 vs 3.0% ; $P < 0.001$). Number of CL on day 5 was similar for control and hCG cows (1.1 vs 1.1 ; $P = 0.61$). The luteal area was increased by hCG (921.6 vs 766.0 mm²; $P < 0.001$) because of increased number of CL (2.20 vs 1.1 ; $P < 0.001$). Pregnancy rates on days 28 and 42 were not affected by hCG ($P > 0.60$). However, embryos from donor heifers fed gossypol resulted in lower PR at 28 (23.3 vs 33.3% ; $P = 0.07$) and 42 (20.5 vs 29.6% ; $P = 0.08$) d of gestation. Treatment with hCG induced an accessory CL, but did not improve pregnancy rates. However, consumption of 8 to 16 g/d of free gossypol by embryo donor heifers reduced pregnancy rates despite grade

quality of embryos. Our data suggest that the negative effects of gossypol on fertility in cows are mediated by changes in embryo viability in spite of similar morphology.

Key Words: Gossypol, Dairy Cows, Reproduction

102 Influence of duration of proestrus on circulating estradiol, the LH surge and luteal function in cattle. G. A. Bridges*, M. L. Mussard, C. L. Gasser, D. E. Grum, and M. L. Day, The Ohio State University, Columbus.

Previous research from our lab suggests that length of proestrus preceding an induced ovulation can influence subsequent pregnancy rates. The present objective was to compare the endocrinology associated with a GnRH-induced ovulation in cows with either a short or long proestrus. On d -6.25 (d 5.8 of the estrous cycle), transvaginal follicular aspiration was used to remove all ovarian follicles > 4 mm from non-lactating beef cows ($n = 16$). Cows received PGF_{2 α} on either d -2.2 or -1.2 to induce either a long (2.2 d; LP) or short (1.2 d; SP) proestrus before a GnRH-induced ovulation on d 0 and AI on d 0.5. Ovarian ultrasonography was performed on d -6.25, -3, -2, -1, 0, 2, 6 and 12 to evaluate follicular and luteal development. Blood samples were collected at 8-hr intervals from d -2.2 to 0, at 0, 0.5, 1, 2, 4, 6, 8, and 12 h after GnRH, then daily from d 3 to 8 and every 2 d thereafter until d 26. Diameter of the largest ovulatory follicle on d 0 did not differ between treatments (LP; 12.4 ± 0.3 mm, SP; 11.8 ± 0.3 mm). Plasma concentrations of estradiol (E2) were greater ($P < 0.05$) in the LP than SP treatment from d -1.5 to 0. Pregnancy rate did not differ (56%), however across treatments, cows with E2 > 10 pg/ml on d 0 had increased ($P < 0.05$) pregnancy rates compared to cows with E2 $\#8804$ 10 pg/ml (88.9 vs 14.3%, respectively). The GnRH induced LH surge pattern did not differ between treatments, but cows that conceived tended ($P = 0.10$) to have an LH surge of greater magnitude. Cows in the SP treatment tended ($P = 0.10$) to have increased incidences of short-lived CL (50 vs 12.5%) and decreased ($P = 0.06$) concentrations of progesterone from d 3 to 14 than cows in the LP treatment. In conclusion, cows with a shorter proestrus had decreased preovulatory concentrations of E2 and in the ensuing estrous cycle, luteal function tended to be compromised compared to cows with a longer proestrus. The putative role of these endocrine differences in determining the likelihood of pregnancy requires further investigation.

Key Words: Cattle, Estradiol, Progesterone

103 Factors influencing fetal loss in dairy cattle. F.D. Jousan*, M. Drost, and P.J. Hansen, University of Florida, Gainesville.

Since reproductive function in dairy cattle has declined coincident with increased milk production, fetal loss may be greatest for high-producing cows. Heat stress, which compromises early embryonic survival, could also conceivably affect fetal loss. The purpose of this study was to evaluate effects of lactation number, milk yield and somatic cell count score (scs) at breeding, number of times bred, season of breeding, and the interval from calving to breeding (days open) on fetal loss. Holstein cattle at the University of Florida Dairy Research Unit were palpated to determine pregnancy status between d 40-50 of gestation and again at d 70-80. Early fetal loss was defined as loss that occurred after d 40-50 but before d 70-80. Mid-to-late fetal loss represented losses after d 70-80 but before expected calving. Lactating females ($n = 950$) had higher early and mid-to-late fetal loss than non-lactating heifers [$n = 386$; $6.3 \pm 0.7\%$ vs $3.6 \pm 1.1\%$ for early fetal loss ($P = 0.05$) and $3.7 \pm 0.6\%$ vs $1.1 \pm 0.9\%$ for mid-to-late fetal loss ($P < 0.05$)]. For lactating animals, early fetal loss was affected by days open ($P < 0.05$; < 75 d: $5.8 \pm 3.8\%$, 75-150 d: $2.6 \pm 1.8\%$, 151-300 d: $10.0 \pm 2.0\%$, and > 300 d: $7.9 \pm 3.0\%$). Similarly, mid-to-late fetal loss was affected by days open ($P < 0.05$; < 75 d: $1.9 \pm 2.9\%$, 75-150 d: $4.2 \pm 1.3\%$, 151-300 d: $4.4 \pm 1.6\%$, and > 300 d: $10.5 \pm 2.3\%$) and scs ($P < 0.01$; $\#8804$ 2.5: $2.7 \pm 1.4\%$, > 2.5 -5.0: $3.6 \pm 1.3\%$, and > 5.0 : $9.3 \pm 1.7\%$). Early and mid-to-late fetal loss for lactating animals was not significantly influenced by season, milk yield, lactation number, or times bred. Similarly, there was no significant effect of times bred or age at breeding on early or mid-to-late fetal loss for heifers. In conclusion, days open and scs at breeding influence the lactating cow's ability to maintain pregnancy, and lactating females are most likely to suffer early or mid-to-late fetal loss. However, increased

milk yield or heat stress was not associated with increased fetal loss. (Research Support: USDA IFAFS grant 2001-52101-11318).

Key Words: Dairy Cattle, Fetal Loss, Pregnancy

104 Effect of a CIDR insert and flunixin meglumine administered at the time of embryo transfer on pregnancy rate and resynchronization of estrus in beef cattle. S. H. Purcell*¹, B. E. Beal¹, and K. R. Gray², ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Cross Country Genetics North, Westmoreland, KS.

The objectives of this study were to evaluate the effects of flunixin meglumine (FM), an inhibitor of PGF_{2α} synthesis, administered at the time of embryo transfer (ET) and insertion of an intravaginal progesterone-releasing device (CIDR) at the time of ET on pregnancy rates (PR) and the resynchronization of estrus. Beef cows (n = 552) and heifers (n = 160) in three locations were assigned randomly within age to one of four treatments: FM = injection of FM (500 mg i.m.; Phoenix Scientific; St. Joseph MO) 2 to 12 min prior to ET; CIDR = insertion of a CIDR

(1.38 g progesterone; Pfizer; New York, NY) for 13 d immediately following ET; FM + CIDR or untreated control. Fresh or frozen embryos were randomly assigned to be transferred to recipients on d 6 to 9 of the estrous cycle. At one location, recipients (n = 493) were observed for signs of return to estrus beginning 9 d after ET. Recipients that returned to estrus were bred by AI or received an embryo 7 d after estrus. Pregnancy was diagnosed (d 28 to 60) by ultrasonography or palpation per rectum. PR were analyzed using the LOGISTIC procedure of SAS. Variation in the timing of the return to estrus was determined by an F-test for heterogeneity of variances. PR following the initial ET was not affected by CIDR administration (P > 0.05; 69% with CIDR, 76% without CIDR). There was a significant FM x location interaction on PR (Location 1, 89 vs 57%; Location 2, 70 vs 66%; Location 3, 74 vs 77% for FM vs no FM, respectively). The timing of the return to estrus was less variable (P < 0.01) for recipients fitted with a CIDR, but PR following AI (69 and 64%) or second ET (74 and 82%) did not differ (P > 0.05) in cows receiving or not receiving a CIDR, respectively. Effects of FM on PR varied among locations and CIDR insertion at ET reduced variation in timing of the return to estrus.

Key Words: Embryo Transfer, Flunixin Meglumine, CIDR

PSA-Environment and Management-Enteric Bacteria

105 Utilization of an experimental chlorate product in reduction of necrotic enteritis in broiler chickens. J. L. McReynolds*¹, J. A. Byrd¹, R. C. Anderson¹, T. S. Edrington¹, T. L. Poole², R. W. Moore², L. F. Kubena¹, and D. J. Nisbet¹, ¹USDA-ARS, Southern Plains Agriculture Research Center, College Station, TX, ²USDA-ARS, Russell Research Center, Athens, GA.

Clostridium perfringens (CP) is one of the etiologic agents of Necrotic Enteritis (NE). The clinical signs of this disease include depression, decreased appetite, diarrhea, and severe necrosis of the intestinal tract. Development of new technologies to combat this costly disease is needed in the commercial poultry industry. In the present investigation, in vitro and in vivo studies were conducted to determine the effects of an experimental chlorate product (ECP) on CP. In the in vitro study intestinal contents were obtained from single comb White Leghorn laying hens and diluted (1:1) with thioglycollate enrichment medium. The contents were divided into six 10 mL aliquots and assigned to the following experimental groups: a control, ECP with a 5 mM chlorate ion equivalent, or ECP with a 10 mM chlorate ion equivalent (2 replicates/group). The effects of ECP were evaluated in vitro over time. By 3 h there was a significant reduction in CP (P < 0.05) in the 5 mM ECP (3.88 Log₁₀), and 10 mM ECP (3.29 Log₁₀) when compared to the control (5.51 Log₁₀). In the in vivo experiment, evaluations of the ECP administered in the drinking water and in the feed (1X ECP is equivalent to a 15 mM chlorate ion concentration) showed reductions in clinical signs associated with NE. Lesion scores were reduced significantly in birds fed the ECP (1.25) when compared to the controls (2.1). The incidence of CP and mortality were also reduced significantly in birds fed the ECP. Populations of generic *E. coli* were significantly lower in all of the treatment groups compared to the controls. These results indicate that an ECP may provide the poultry industry with an additional management tool for controlling NE.

Key Words: *Clostridium perfringens*, Experimental Chlorate Product, Necrotic Enteritis

106 The use of biodegradable pellets for the control of *Salmonella* in broilers during feed withdrawal. J. A. Byrd*¹, L. H. Stanker², J. L. McReynolds¹, and D. J. Nisbet¹, ¹USDA-ARS, Food & Feed Safety Research Unit, College Station, TX, ²USDA-ARS, Foodborne Contaminants Research Unit, Albany, CA.

Poultry undergo a feed withdrawal (FW) prior to transport to the processing plant. During FW, poultry tend to peck at floor litter that may be contaminated with *Salmonella* and *Campylobacter*. These pathogens could be transported to the processing plant in the upper gastrointestinal of poultry which may leak out during slaughter and cross contaminate other carcasses. One approach would be to supply a disinfectant and another source of nutrition that would not physically fill the upper gastrointestinal tract. Presently, we evaluated the use of a novel biodegradable starch extruded pellet (BP) that can be treated with bactericidal or bacteriostatic compounds. The BP was provided to market-age broilers during an 8 h FW. All broilers were challenged with 10⁸

Salmonella Typhimurium (ST) by oral gavage 6 days prior to FW. One h after the onset of FW, 454 g of BP containing either 2% lactic acid (LA), citric acid (CA), or D-limonene + CA + diosulfosuccinate (DSS) were placed on the litter in each pen. In two experiments, broiler provided BP containing LA caused a significant decrease (P < 0.05) in the incidence of ST in crop contents (40%) as compared to the controls (65%). Similarly, broilers provided BP containing LA (0.8 Log₁₀ ST/g crop content) caused a significant decrease (P < 0.05) in the number of ST recovered in the crop compared to controls (1.87 Log₁₀ ST/g). The material is environmentally compatible in that it will degrade in poultry grow-out houses thus providing beneficial bacteria a food source without physically filling the gastrointestinal tract. These studies suggest that incorporation of this biodegradable material in the broiler grow-out house during pre-transport feed withdrawal may reduce *Salmonella* and *Campylobacter* contamination of crops and broiler carcasses at processing.

Key Words: Salmonella, Biodegradable, Crop

107 Apparent absence of horizontal transmission of *Campylobacter* among caged broiler breeder roosters. R. J. Buh¹, N. A. Cox¹, J. S. Bailey¹, J. L. Wilson², L. J. Richardson^{1,2}, D. E. Cosby¹, and D. V. Bourassa^{1,2}, ¹USDA-ARS Russell Research Center, Athens, GA, ²University of Georgia, Athens.

This study was undertaken to evaluate the potential for horizontal transmission of *Campylobacter* between adjacent caged broiler breeder roosters. Feces and semen from individually caged roosters at 41 wk of age were sampled for the presence of *Campylobacter* for 3 consecutive wk and determined to be negative. Three roosters were challenged with a marker strain of *Campylobacter jejuni* either orally using 1.0 mL of suspension (1.4 10⁶ / mL). Three additional roosters were challenged by dropping 0.1 mL of suspension on the everted phallus immediately after semen collection. Six non-challenged roosters were placed in wire-floored cages interspersed between the challenged roosters. Roosters were meal fed daily in individual feed troughs and provided individual nipple drinkers per cage. Feces and semen samples were collected weekly from each rooster for a period of 5 wk post-challenge. The 6 non-challenged adjacently caged roosters were consistently negative for both feces and semen from 1 through 5 wk. At 6 wk roosters were necropsied and samples collected from the thymus, spleen, liver/gall bladder, and ceca, and all were negative for non-challenged roosters. Challenged roosters all produced *Campylobacter* positive feces and semen at 1 and 2 wk post-challenge. At 3 wk post challenge all fecal samples were positive for *Campylobacter*, but 2 semen samples were negative, one from each challenge route. At 4 wk post-challenge all semen samples were negative for *Campylobacter*, and only 3 fecal sample remained positive (2 for oral and 1 for phallus challenge routes). At 5 wk post challenge all semen and fecal samples were negative for *Campylobacter*. Necropsy samples from challenged roosters were negative for the thymus, spleen, and liver/gall bladder at 6 wk post-challenge. Two ceca samples were found to contain *Campylobacter*, one from each challenge route. These results indicated

that *Campylobacter* is not readily transferred horizontally between adjacently caged roosters. At 6 wk the presence of *Campylobacter* in the ceca was undetected in 4 of the 6 challenged roosters.

Key Words: *Campylobacter*, Broiler Breeder Roosters, Horizontal Transmission

108 Effects of *Aspergillus* meal prebiotic on gut development and ascites mortality. F. Solis*¹, J. M. Balog², G. Tellez¹, S. Higgins¹, A. Torrez¹, A. M. Donoghue², and N. B. Anthony¹, ¹University of Arkansas, Fayetteville, ²USDA/ARS/PP&PSR, Fayetteville, AR.

We hypothesize that the developing gastrointestinal tract of rapidly growing broilers has a significant impact on the eventual development of ascites syndrome. Since the addition of *Aspergillus* meal (AM) prebiotic to poultry feed has been shown to improve gut development, the objective of this study was to determine if AM would reduce the negative effects of hypoxia on the gut and reduce ascites incidence. Four hundred (200 commercial and 200 susceptible) day old chicks were randomly assigned to either a control feed or a feed with 0.2 % AM added. Groups were reared at either local altitude (390 meters above sea level) or simulated high altitude (2900 meters above sea level). Mortality was checked twice daily and necropsied for ascites. Birds and feed were weighed weekly. At 6 wk the remaining birds were weighed, killed and organs were weighed. There were no significant effects due to prebiotic feeding for any of the variables evaluated. As previously shown, chickens reared at sea level were heavier (2.01 kg) than those at high altitude (1.13 kg). Also, chickens grown at high altitude showed 84.8% ascites mortality compared with 1.3% at local altitude. Of particular interest in this study was the finding that susceptible chickens had heavier relative gut wt (0.0575), when compared to the commercial birds (0.0511, $P < 0.05$). Interestingly, when measurements were made of the villi length, it became apparent that although susceptible birds have heavier relative gut wts, the duodenal villi were significantly shorter (204.4 μ at high altitude), when compared with the commercial birds (229.4 μ at high altitude). Villi height was also influenced by altitude alone, with both commercial and susceptible birds combined mean duodenal villi height at high altitude was 195.1 μ , while at sea level the mean was 227.4 μ . The results showed that hypobaric hypoxia results in a significant reduction in gut development.

Key Words: Ascites, Prebiotic, Gut Development

109 *Salmonella* and lactobacilli growth in a simulated crop model using chicken or turkey feeds. A. D. Wolfenden*¹, S. N. Henderson¹, R. L. Jarquin¹, G. M. Nava¹, L. R. Bielke¹, J. L. Vicente¹, G. I. Tellez¹, D. J. Donoghue¹, A. M. Donoghue², and B. M. Hargis¹, ¹University of Arkansas, Fayetteville, ²PPPSRU, ARS, USDA, Fayetteville, AR.

The chicken crop is a well known source of *Salmonella* contamination of carcasses at processing. Very recent evidence has been presented suggesting that *Salmonella* may amplify and perhaps colonize the crops of poultry. Presently, we evaluated *Salmonella enteritidis* (SE) or Lactobacilli spp. (LAB) growth (known to produce bacteriocin-like agents inhibitory to SE growth), alone or in combination, in either chicken or turkey feeds, using a previously-published simulated crop model *in vitro*. In exp. 1, 1.25 g of either chick starter or turkey starter were added to tubes and autoclaved. Sterile saline (4.5 ml) was added to each tube. Tubes were divided into 6 groups; chick starter+SE, chick starter+SE+LAB sprayed on feed (1.1x10⁴ cfu/g), chick starter+SE+LAB (10⁶ cfu/ml), turkey feed+SE, turkey feed+SE+LABS (2.0x10⁵ cfu/g) sprayed on feed, turkey feed+SE+LABS (10⁶ cfu/ml). 0.5 ml of 10⁵ SE was added to each tube in groups containing SE. Tubes were individually shaken for 2 sec. and incubated for 2.5 hr at 40C. At 1 or 2.5 hr, cfu of SE or LAB were determined by plating serially on appropriate agar. A significant ($p < .05$) increase in SE was observed in chick starter at 1(4.26 log₁₀ cfu) and 2.5 hr(5.66 log₁₀ cfu) regardless of LAB presence. Interestingly, very little SE amplification occurred when turkey starter was used as the substrate (< 1 log₁₀ cfu), regardless of LAB presence. Experiment II was similar in design. Again, SE was observed to amplify at either 1(4 log₁₀ cfu) or 2.5 hr(6 log₁₀ cfu) in chick starter, with no consistent effect of LAB addition. Very little SE amplification (< 1 log₁₀ cfu) was observed in commercial turkey starter, and addition of LAB at these concentrations did not affect SE recovery. Potential explanations

for amplification of SE in chick starter, but not turkey starter, are currently being explored and may be an important aspect related to the role of crops for contamination of chicken but not turkey carcasses.

Key Words: Crop, *Salmonella*, Lactobacilli

110 Effect of dietary administration of *Aspergillus* meal on broiler chick performance with low protein diets. A. Torres-Rodríguez*¹, C. D. Sartor¹, S. E. Higgins¹, A. D. Wolfenden¹, L. R. Bielke¹, C. M. Pixley¹, A. M. Donoghue², G. Tellez¹, and B. M. Hargis¹, ¹University of Arkansas, Fayetteville, ²PPPSRU, USDA-ARS, Fayetteville, AR.

Aspergillus meal (Fermacto[®], F) is a prebiotic feed additive. In two experiments we evaluated the effect of F with low protein diets on chick performance. In Experiment I, two levels of crude protein (CP), 23 and 19%, with or without F (0.2%) were evaluated. Chickens fed 19%+F were heavier ($p < 0.05$) than 19% alone (243.3 \pm 5.16 vs 205.8 \pm 4.06 std.err., respectively) at 14 days of age. Chickens fed 23% were heavier than both 19% groups (311g \pm 5.49 std.err.). In Experiment II, two levels of CP, 21 and 19%, with and without F (0.2%), were evaluated with 100% and 90% NRC lysine, methionine and tryptophan requirements for 21% and 19% diets, respectively. Both 21% groups were heavier ($p < 0.05$) than 19% groups, whereas 19%+F chickens were heavier than 19% alone (640.46 g \pm 4.98, 656.91 g \pm 5.39 std.err., for 19 alone, and 19%+F, respectively; $p < 0.05$) at 21 days of age. Results from these trials indicate that F may offer a protein sparing effect, potentially allowing for diets with lower levels of protein and amino acids. *Aspergillus* meal might offer better results when protein and amino acid levels are lower than those recommended by NRC or applied in some commercial flocks.

Key Words: *Aspergillus* Meal, Prebiotic, Low Protein Diets

111 Evaluation of an organic acid mixture to reduce *Salmonella enteritidis* in the chicken crop. R. L. Jarquin*¹, A. D. Wolfenden¹, G. M. Nava¹, J. L. Vicente¹, C. D. Sartor¹, A. M. Donoghue², and B. M. Hargis¹, ¹University of Arkansas, Fayetteville, ²PPPSRU, ARS, USDA, Fayetteville, AR.

An organic acid mixture (OAM) consisting of tannic (.024%), lactic (.042%), butyric (.048%) and acetic (.048%) acids (final concentrations) were evaluated in 4 experiments. Each experiment utilized an *in vitro* simulated crop assay which has been described. Briefly, 1.25 grams of chick starter was measured into 13 x 100 mm borosilicate tubes (n=10/replicate) and autoclaved. Sterile saline (4.5mL) was added to each tube with 0.5mL of SE inoculum (1 x 10⁵). In EXP 1 and 2, 0.5x OAM, 1x OAM, or 2x OAM significantly reduced SE recovery by at least one log₁₀ ($p < 0.05$) during a 2 hr incubation at 37° C. However, no effect of higher or lower concentrations of the OAM were observed. Tannic acid alone (.024%) did not reduce SE recovery in these experiments. After *in vitro* testing, water consumption (WC) in the presence of feed or during feed withdrawal (FW) using the OAM or tannic acid alone were measured in market age broilers (4-8 weeks of age) in EXP 3 and 4. Two pens (40 birds/pen) were randomly assigned to each treatment, with treatments consisting of no treatment (control), 1x, 2x, or 3x OAM, or 0.02%, 0.1%, 0.25%, or 0.36% of tannic acid alone in the drinking water (DW). WC was measured at 8 hours. In the presence of feed, no differences in water consumption were observed between the control, 1x OAM, or tannic acid concentrations of 0.02% or 0.1%. However, WC apparently decreased when 2X or 3X OAM or 0.25% or 0.36% tannic acid were administered. During FW, water consumption was decreased (40-70%) in groups receiving either 1X, 2X, or 3X OAM. No effect of 0.02% tannic acid was observed, although 0.25% or 0.36% tannic acid decreased WC (27-52%). Ongoing studies are aimed at evaluation of the effect of DW treatments with selected OAM concentrations on *Salmonella* recovery from market-aged broilers.

Key Words: *Salmonella*, Crop, Organic Acids

112 Cell yield and genetic response in *Salmonella* Typhimurium in a continuous culture during shifts in pH. K. D. Dunkley^{*1}, M. M. Kundinger¹, C. S. Dunkley^{*1}, T. R. Callaway², R. C. Anderson², D. J. Nisbet², and S. C. Ricke¹, ¹Texas A&M University, College Station, ²USDA-ARS, College Station, TX.

Salmonella Typhimurium is attracting world wide attention as it continues to cause foodborne illness to human beings. The organism is resistant to a wide range of anti-infectious agents and as a result the illness is more difficult to treat. The objective of this study was to analyze the expression of specific virulence and stress genes (*hilA* and *rpoS*) in *Salmonella* Typhimurium at various nutritional stress and pH in a continuous culture system. *Salmonella* Typhimurium cells were propagated in continuous cultures with a total volume of 0.50 liter LB minimal medium at 98% turnover rate. Two chemostats were used for adjusting dilution rates and pH levels. Dilution rates were 0.0125 h⁻¹, 0.025 h⁻¹, 0.05 h⁻¹, 0.1 h⁻¹, 0.27 h⁻¹, 0.54 h⁻¹, 1.08 h⁻¹, and 1.44 h⁻¹, while pH levels were 6.1 through 8.0. Results indicated that cell protein increases as dilution rates (D) increase (D 0.0125 h⁻¹, =1184 g cell: 0.27 h⁻¹, =1431g cell, however, at 0.54 h⁻¹, there was a decline in the g/cell protein quantity. This suggests that when dilution rate reaches washout in the chemostat, the cell mass decreases. Changes in glucose yield (Y_{glc}) also indicated that as the pH increases so does the Y_{glc} (pH 7.29=243±14g cell/mol glucose utilized: pH 6.15= 30±13g cell/mol glucose utilized (P>0.05)). To analyze gene expression, samples were stored in RNAsprotect (Qiagen, Valencia, CA) in duplicate. Real-time PCR reactions were performed on an ABI Prism 7700 Sequence Detection System (Perkin-Elmer Applied Biosystems, Foster City, CA). Samples were analyzed using the Comparative Ct ($\Delta\Delta C_t$) method by normalizing to the endogenous control gene (*rsmC*). Both *hilA* and *rpoS* expression appeared to change in response to corresponding pH and Y_{glc} transitional changes in the continuous culture.

Key Words: *Salmonella*, Continuous Flow Culture, Virulence

113 Isolation and prevalence of *Campylobacter* in the reproductive tracts and semen of commercial turkeys. K. Cole^{*1}, J. S. Holliman¹, P. J. Blore¹, A. M. Donoghue², and D. J. Donoghue¹, ¹Department of Poultry Science, University of Arkansas, Fayetteville, ²Poultry Production and Product Safety Research Unit, ARS, USDA, Fayetteville, AR.

Campylobacter is one of the leading causes of human gastroenteritis in the United States and epidemiological evidence has implicated raw poultry products as a significant source of human infection. *Campylobacter* frequently colonizes the avian intestine but recent research indicates that this organism can also colonize the oviduct of laying hens and broiler breeders. The present studies were undertaken to determine if *Campylobacter* is present in the reproductive systems of commercial turkeys. In the first study, the reproductive tracts of 11 hens and 17 toms were aseptically excised and the segments (female: vagina, shell gland, isthmus, magnum, and infundibulum; male: ductus deferens and testes) were swabbed with a dry cotton sterile swab. The swabs were incubated for 24 h in *Campylobacter* enrichment broth and 0.1 mL of

the enriched sample solution was streaked onto *Campy*-line agar plates and incubated at 42°C for 48 h in a microaerophilic environment for detection of *Campylobacter*. Of the 11 hens sampled, *Campylobacter* was isolated from the vagina (10/11), the shell gland (7/11), the isthmus (8/11), the magnum (6/11), and the infundibulum (3/11). Of the 17 toms sampled, *Campylobacter* was isolated from the ductus deferens (8/17) and the testes (2/17). In a second study, pooled semen samples from 7 separate farms were randomly collected by abdominal massage over a period of 13 weeks. The pooled semen samples were serially diluted and 0.1 mL of each dilution was plated on *Campy*-line agar and incubated at 42°C for 48 h in a microaerophilic environment for enumeration. *Campylobacter* was isolated from 57 of the 59 pooled semen samples and levels ranged from <10¹ to 1.58 x 10⁶ cfu/mL of semen. Naturally occurring *Campylobacter* is present in the reproductive tracts and semen of commercial turkeys and may enable vertical transmission of *Campylobacter* from the hen to the poult.

Key Words: *Campylobacter*, Turkeys, Reproductive Tract

114 Evaluation of the effect of fish meal supplementation on *Salmonella enteritidis* growth in chick starter *in vitro*. S. N. Henderson^{*1}, A. D. Wolfenden¹, R. L. Jarquin¹, G. M. Nava¹, J. A. Byrd², and B. M. Hargis¹, ¹University of Arkansas, Fayetteville, ²USDA-ARS-SPARC, College Station, TX.

While the contents of chicken crops are well known to play an important role in contamination of carcasses at processing, recent evidence has been presented suggesting that *Salmonella* may amplify and perhaps sometimes colonize the crop *in vivo*. *Salmonella* infections have been associated with the use of animal/fish meal supplementation, probably because of the known increased contamination frequency of these feedstuffs. Presently, we evaluated the ability of *Salmonella enteritidis* (SE) to amplify in a simulated *in vitro* crop assay, using either an all vegetable chick starter diet or a similar diet supplemented with fish meal (5%). In three replicate experiments, three different chick starter formulations, two with all vegetable protein sources, and one with fish meal (5%) supplementation, were compared for ability to support *Salmonella* growth *in vitro*. Briefly, for each experiment, 1.25 g of each feed type was measured into 13 x 100 mm borosilicate tubes (n=10/replicate) and autoclaved. Sterile saline (4.5mL) was added to each tube with 0.5mL of SE inocula at initial concentrations of 6.75x10³, 1.15x10⁵, and 8x10⁴ colony forming units (cfu)/mL, for each experiment, respectively. The tubes were then incubated at 40°C for 1 or 2.5 hrs, and cfu/ml were determined by serial dilution and spread plate enumeration on selective medium. Each of the feed types, in each of three experiments, supported the apparent amplification of SE by > 1 log₁₀ cfu/ml during the 2.5 hr incubation. Inclusion of fish meal did not affect the ability of SE to grow in the feed substrates in any of the 3 experiments. Since inclusion of fish meal did not enhance the ability of *Salmonella* to grow in this *in vitro* crop model, these data suggest that fish meal may not be important for supporting *Salmonella* growth in the crops of chickens.

Key Words: *Salmonella*, Crop, Fish Meal

PSA-Nutrition: Amino Acids and Vitamin/Mineral Nutrition I

115 Evaluation of guar by-products in high production laying hen diets. C. Zhang^{*}, A. L. Cartwright, J. B. Carey, and C. A. Bailey, Department of Poultry Science, Texas A&M University, College Station.

Guar (*Cyamopsis tetragonoloba*) is a drought-tolerant annual legume grown for its high concentration of galactomannan gum. Guar seeds are split to produce guar gum and both a high protein germ fraction and a lower protein hull fraction, which are usually recombined to create guar meal. The price of guar meal in the United States is about half that of soybean meal and therefore of potential value poultry diets. A 5 x 5 Latin square experiment was conducted to evaluate using low concentrations of guar germ or a combination of guar germ and hull (guar meal) in high production laying hen diets. A total of 125 Lohmann laying hen pullets (21-week-old) of similar body weight were assigned to 5 groups of 5 replications with 5 birds in each replication. Hens were fed either a non-guar control diet, or a diet with 2.5 and 5% guar germ, or 2.5 and 5% guar meal for 20 weeks. There was no difference (P >0.05) in hen-day egg production which averaged 96.09, 94.43, 94.34, 94.38 and

96.31%, or feed consumption which averaged 99.2, 101.2, 101.5, 103.0 and 103.0 g/day per hen, respectively. The grams feed consumed per gram egg (FCR) were 1.798, 1.856, 1.855, 1.940 and 1.834, respectively, with the 2.5% guar meal-fed group higher than the other groups. Feeding guar did not affect yolk color or shell quality (shell thickness, egg breaking force and specific gravity), but decreased Haugh units. A guar fraction x concentration interaction was detected with respect to FCR which decreased in birds fed guar meal as concentrations increased from 2.5 to 5%. The results showed that both guar germ and guar meal can be fed to high production laying hens at up to 5% without adverse effects on laying hen performance and egg quality.

Key Words: Guar, Laying Hen, Egg Production

116 Effect of dietary nutrient density, feed form, and lighting on the growth performance of broiler chickens. K. E. Brickett* and H. L. Classen, *University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this research was to examine the main and interactive effects of dietary nutrient density (2800, 2950, 3100 kcal/kg ME), feed form (mash, crumble/pellet) and lighting program (20L:4D, 12L:12D) on production characteristics of broilers raised to a young age (35 days). Diets (starter, grower and finisher) were formulated so that amino acid levels were in proportion to diet energy level. Lighting programs were initiated at 4 days of age and maintained until trial end. Body weight was not affected by nutrient density when diets were fed in a crumble/pellet form but decreased in a linear fashion with density when fed as a mash. Final body weight for birds fed mash diets were smaller than for those fed crumble/pellet diets. Feed to gain ratio decreased with increasing nutrient density but was not affected by feed form. Feed intake decreased with increasing nutrient density and was lower for birds fed mash. The effect of nutrient density on feed intake was less when birds were fed mash in contrast to crumble/pellet diets as indicated by a significant interaction. Diet nutrient density did not affect mortality but feeding a mash diet decreased death loss (3.83%) in comparison to feeding processed feed (5.63%). The increase in mortality can be attributed to an increase in the number of culls due to leg abnormalities. Mean gait scores suggested an increase in leg abnormalities for birds fed processed feed (0.756), as compared to those fed a mash (0.342). Use of 12L:12D reduced body weight, feed to gain ratio, feed intake and mortality in comparison to the use of 20L:4D. Overall there were no interactions between lighting program and diet main effects. The data demonstrate the importance of treatment effects and their interactions on broiler performance and provide data that permits selection of nutrition and management programs on the basis of economic and animal welfare considerations.

Key Words: Energy, Mash, Photoperiod

117 Satellite cell mitotic activity of broilers receiving lysine deficient diets. S. Pophal*^{1,2}, P. Mozdziaik², and S. Vieira¹, ¹*Universidade Federal do Rio Grande do Sul*, ²*North Carolina State University, Raleigh.*

Myofiber growth is dependent upon the contribution of new nuclei from the mitotically active satellite cell population. The effect of starvation or feeding with different levels of amino acids within different ideal protein levels on satellite cell mitotic activity was studied using 3-day old male broiler chicks. The experiment consisted of one starved group and 4 fed groups (n=10 per group) receiving differing levels of digestible lysine 0.82%, 0.99%, 1.16% and 1.33%. The feeds were formulated to contain 2,950 ME kcal/kg and an ideal balance for essential amino acids. All other nutrients met NRC recommendations (1994). Birds were housed in battery cages, receiving feed and water ad libitum, except for the starved group, from hatch to 3 days of age. All chicks were injected with 5-Bromo-2'-deoxyuridine (BrdU) 2 hours before being killed. By the end of experiment, each bird was killed and the Pectoralis thoracicus was removed, fixed, dehydrated, cleared and embedded in paraffin. Mitotically active satellite cells were identified in the Pectoralis thoracicus using BrdU immunohistochemistry and enumerated using computer-based image analysis. Mitotic activity in the starved group was significantly lower than the fed groups. Within the fed groups the satellite cell mitotic activity was highest for the treatment with 0.82% digestible lysine. Myofiber cross sectional area was also reduced on the starved group compared to fed treatments. The higher satellite cell mitotic activity observed for the 0.82% group, at day 3, may reflect a longer period for satellite cell activation. This activation delay may be a result of a deficiency, because a level of 0.82% of digestible lysine can be insufficient for early pectoral muscle growth. The results of the current study suggest that a satellite cell pathway may be sensitive to early nutritional supplementation.

Key Words: Muscle, Satellite Cell, BrdU

118 Synthetic methionine and feed restriction effects on performance and meat quality of organically-reared broiler chickens during fall months. N. P. Buchanan*, A. S. Parsons, N. J. Baker, and J. S. Moritz, *West Virginia University, Morgantown.*

Synthetic methionine has received scrutiny in organic production due to its extraction process and a belief that it is used for growth promotion rather than bird health. Organically reared poultry have access to pasture that may supply additional nutrients. The objective of the current study was to evaluate the extent in which birds will utilize nutrients, especially methionine, from forage and the subsequent effects on performance and carcass quality. Three hundred and eighty 1-day old Ross 308x344 broilers were reared from 0-to-3-weeks in floor pens. On day 21, 240 birds were randomly selected and moved into houses with access to pasture for five weeks. Experimental grower diets consisted of two different methionine levels (including or excluding crystalline methionine) arranged in a factorial structure with two different levels of feed access (*ad libitum* or 50% intake of *ad libitum*). In addition, fifty-six birds were withheld pasture access and fed similar diets. Birds with access to forage and comparable feed access had similar live weight gain (P=0.4676) and feed intake (P=0.5182) despite variation in dietary methionine. These birds also had similar hot carcass weight (P=0.0850), fat pad weight (P=0.6806), and breast weight (P=0.0345). A comparison of birds with and without access to pasture showed that birds without access to pasture had an increase in LWG (P=0.0001) and FI (P=0.0001). Feed efficiency did not differ between groups. Carcass weight (P=0.0001) and fat pad weight (P=0.0001) were larger for birds without access to pasture. However, these birds had smaller breast weight (P=0.0001). These results demonstrate that birds given access to pasture during the fall, with no synthetic methionine supplementation, can adequately meet their nutrient requirements. Furthermore, providing access to forage may improve carcass quality by decreasing fat pad weight and increasing breast yield.

Key Words: Organic Production, Broiler Production, Methionine

119 Synthetic methionine and feed restriction effects on performance and meat quality of organically reared broiler chickens in the summer months. A. S. Parsons*, N. J. Baker, and J. S. Moritz, *West Virginia University, Morgantown.*

Organic broiler production addresses consumer concerns with drug/animal by-product use and bird welfare. Synthetic methionine is typically added to corn-soybean based diets to meet broiler methionine requirements. However, the use of synthetic methionine in organic feed has recently become a concern to consumers. Research focusing on the removal of synthetic methionine from corn-soybean based diets for organically-reared birds does not exist. The objective of the current study was to determine the effects of synthetic methionine use as well as feed restriction on performance and meat quality of organically-reared broiler chickens. Diets consisted of two different methionine levels (excluding and including synthetic methionine) each provided for *ad libitum* or restricted access. Diets were fed to four replicate pens of 15 straight-run 308x344 Ross broilers, each having free access to pasture during the day. Additionally, broilers were reared without pasture access, but given similar diets. Birds given *ad libitum* feed and pasture access had similar live weight gain (LWG), feed intake (FI), and feed efficiency (FE) (P#88050.05) despite variation in dietary methionine. In addition, these birds did not differ in carcass characteristics (P#88050.05). Birds without pasture access, had increased LWG (P<0.05), decreased FI (P<0.05) and increased FE (P<0.05) compared to pastured birds fed similar diets. Pastured birds had decreased fat pad weights relative to carcass weight (P#88040.05), while all other carcass characteristics remained similar to birds without pasture access. Birds given restricted feed and pasture access had similar LWG and FI despite methionine level; however FE varied (P#88040.05) based on period of measurement (21-38d) or (38-56d). These results suggest that birds fed diets without synthetic methionine could compensate for the methionine deficiency if diets are provided for *ad libitum* consumption and summer forage is accessible.

Key Words: Organic Production, Broiler Production, Methionine

120 Effect of dietary copper source on broiler chicken performance and immune responses. Vanessa J. Arias* and Elizabeth A. Koutsos, *California Polytechnic State University, San Luis Obispo.*

Dietary copper sulfate (CS) and Tri-Basic copper chloride (TB) were examined to test their effects on broiler body weight (BW) and immune responses. Experiment 1 was a 6 x 2 factorial design using 6 diets containing a basal diet with no additional copper (Neg. control), 125ppm CS or TB, 188ppm CS or TB, or a basal diet + bacitracin (Pos. control). Birds were housed in Petersime batteries at 8 chicks/rep, 8 reps/diet. At 3 wk all diet groups were weighed, then placed into 1 of 2 treatments; chicks were either vaccinated with lipopolysaccharide (LPS, 100 µg/kg BW) or unvaccinated and sampled 24 h later. BW was significantly affected by diet at 3 wk ($P < 0.05$). Broilers fed Pos. control diet weighed significantly less than birds fed 125ppm CS, 188ppm TB, and 188ppm CS ($P < 0.05$). Plasma Zn was significantly reduced by LPS ($P < 0.01$) for all birds, except for birds fed 125 ppm CS or TB ($P < 0.05$). There was a significant increase in plasma Cu and liver weights in LPS versus unvaccinated birds ($P < 0.01$ for each). Experiment 2 was a completely randomized block design with four diets using a basal diet containing no additional copper (Neg. control), 188ppm TB or CS, or basal diet + bacitracin and roxarsone (Pos. control). Birds were housed in floor pens at 65 chicks/pen, 8 pens/diet. At 13 d, TB and CS diets had significantly increased BW compared to Neg. control ($P < 0.05$). At 31 d CS diets had significantly increased BW compared to Neg. control ($P < 0.05$). Diet significantly affected carcass weight ($P < 0.01$); specifically TB and CS-fed birds had significantly increased carcass weight compared to Neg. control ($P < 0.03$, $P < 0.01$, respectively). Finally, TB diet had greater plasma Cu compared to Neg. or Pos. control ($P < 0.05$). These data demonstrate that dietary copper sources have some positive effects on broiler performance, similar to bacitracin control. Effects on inflammation are variable, but 125ppm CS or TB demonstrate some anti-inflammatory properties. Further effects on immune response will be discussed in relation to gut histology and antibody titers.

Key Words: Copper, Inflammation, Broiler

121 Effects of copper source and concentration on phytate phosphorus hydrolysis by Phytase in vitro. Y. Pang* and T. Applegate, *Department of Animal Science, Purdue University, West Lafayette, IN.*

Higher concentrations of copper (Cu) in the diet may decrease phytate phosphorus (PP) hydrolysis because of the chelation of Cu with the phytin molecule. Different sources of Cu may affect the activity of phytase at different pH conditions. Therefore, five Cu sources (Cu sulfate (Cu Sul), Cu chloride (Cu CL), tri-basic copper chloride (TBCC), Cu lysinate (Cu Lys) and Cu citrate (Cu CIT)) were studied in vitro at pH 2.5, 5.5 and 6.5 to determine how Cu from each of these sources affects PP hydrolysis by phytase. Five Cu concentrations were used for these studies (0, 62.5, 125, 250 and 500 ppm), and were incubated at 40-41°C for 60 min. The values were expressed by the relative percentage of PP hydrolysis of the 0ppm Cu treatment from separate assays. At pH 2.5, 500ppm Cu Sul inhibited PP hydrolysis (≤ 0.05), whereas, both 250 ppm and 500ppm Cu from Cu CL inhibited PP hydrolysis. No concentrations of Cu from TBCC, Cu Lys or Cu CIT inhibited PP hydrolysis. At pH 5.5, addition of either Cu Sul or Cu CL between 62.5 and 500 ppm inhibited PP hydrolysis from 23.1 to 78.0% (≤ 0.05). Increasing pH to 6.5 increased the extent of inhibition for Cu Sul and Cu CL treatments such that 62.5ppm to 500ppm caused an 89.8 to 95.4% inhibition (≤ 0.05). 500 ppm Cu from TBCC inhibited PP hydrolysis at pH 2.5, 5.5 and 6.5 by 0%, 13.4% and 51.5%, respectively (≤ 0.05). Cu Lys did not affect PP hydrolysis at both pH 2.5 and 5.5, however, increasing pH to 6.5 caused around 39.7 to 48.6% inhibition (≤ 0.05). Cu CIT did not affect PP hydrolysis at pH 2.5, but it inhibited PP hydrolysis at pH 5.5 (≤ 0.05). Increasing pH to 6.5 greatly increased the inhibition such that 500 ppm Cu inhibited PP hydrolysis by 92.1% (≤ 0.05). In conclusion, pH had an important effect on how Cu affects PP hydrolysis in that inhibition occurred much more at pH 5.5 and pH 6.5 than at pH 2.5; Among five Cu sources, TBCC and Cu Lys and Cu CIT inhibited PP hydrolysis much less than Cu Sul and Cu CL.

Key Words: Copper Source, Phytate Phosphorus, Phytase

122 Evaluation of 25-hydroxycholecalciferol as a cholecalciferol substitute for broiler breeders. A. Atencio*, H. M. Edwards, and G. M. Pesti, *University of Georgia, Athens.*

An experiment was conducted to determine the relative bioavailability (RBV) of 25-hydroxycholecalciferol (25(OH)D₃) in comparison to cholecalciferol for hen day egg production (HDEP), hatchability (HAT), embryo mortality during the early (1-10 days of incubation EEM) and late stages (11-21 days LEM). The study was conducted with 77 to 90 week old molted Ross broiler breeders in an environment excluding UV light. A basal D₃ deficient diet and this diet supplemented with three levels of D₃ (125, 500, and 2,000 IU/kg of diets) and two level of 25(OH) D₃ (125 and 500 IU/kg of diets) were fed. Three repetitions of seventeen hens were used for each treatment group. No D₃ source was used in the vitamin premix and no animal byproduct was used in the corn, soybean meal and wheat middlings basal diet to guarantee that no unintentional vitamin D activity was present in the experimental diets. Data were collected weekly for HDEP, HAT, EEM and LEM. Slope ratio analyses were performed using the logarithm of 0, 125 and 500 plus 1 with the data from 81 to 88 weeks of age. The RBVs found were 140, 132, 122 and 127% for HDEP, HAT, EEM and LEM, respectively. The HDEP during the 14 weeks of the experiment was 2.09 times higher for 25(OH) D₃ when compared with D₃ at the 125 IU/kg level. However, at the 500 IU/kg level the difference was only 1.05 higher for 25(OH) D₃. Hatchability was also 1.67 times higher for 25(OH) D₃ at 125 IU/kg level than D₃; however, no difference was observed between the sources at 500 IU/kg. Late embryo mortality was reduced 4 times by 25(OH) D₃ when compared with D₃ at 125 IU/kg level and only 1.26 times at 500 IU/kg level. The potency of 25(OH) D₃ in relation to D₃ depends on the levels tested. When comparing vitamin D sources, 25(OH) D₃ has greater potency than D₃ only at very low levels of supplementation.

Key Words: Broiler Breeders, Vitamin D₃, 25-Hydroxycholecalciferol

123 Decreasing the time required for the auxotroph *Lactobacillus rhamnosus* assay by adaptation to microtiter plates. J. L. Golbach*, C. L. Woodward, V. I. Chalova, and S. C. Ricke, *Texas A&M University, College Station.*

Riboflavin is an essential part of animal diet by playing a significant role in the metabolism of carbohydrates, fatty acids, and amino acids. Riboflavin is also required for the utilization of oxygen, red blood cell formation, antibody production, and growth. Some specific sources of riboflavin are organ meats, nuts, cheese, eggs, milk, lean meat, green leafy vegetables, fish, legumes, whole grains, and yogurt. The objective of this research was to reduce time of the assay by scaling it down into a microtiter plate while still maintaining the precision of the original tube assay. The organism that is used most commonly to quantify riboflavin is *Lactobacillus rhamnosus* ATCC 7469 formerly known as *Lactobacillus casei*. The Bacto Riboflavin Assay Medium from *The Difco Manual* was used as a guideline for transferring the riboflavin assay from a tube assay to a microtiter plate assay. Micro Inoculum Broth was inoculated with *L. rhamnosus* and grown overnight at 37°C. The bacteria were washed three times with sterile 0.85 percent saline solution. Riboflavin Assay Medium was prepared and riboflavin standard was added to achieve concentrations that range from 2.5 ng/mL to 30 ng/mL. The solutions were autoclaved and transferred to a microtiter plate. The microtiter plates were inoculated and incubated at 37°C for 8 hours and values were read by a Spectra Flour Plus microtiter plate reader. The standard growth curve for the riboflavin assay was linear from 0 ng/mL up to 10 ng/mL with an average R² value of 0.99. The average variance for the optical density A₆₀₀ values between 0 ng/mL and 10 ng/mL was $\pm 4.48 \times 10^{-5}$ A₆₀₀. The microtiter assay reduced the amount of time required for sufficient bacterial growth response to generate linear standard curves from 22 hours down to 8 hours. This scaled-down assay can be utilized for the determination of riboflavin in more samples of potential nutritional sources such as poultry feeds and poultry products.

Key Words: *Lactobacillus Rhamnosus*, Riboflavin, Microtiter Plate Assay

124 Effect of anticoccidial medication upon broilers infected with eimeria species during the starter or grower phase of production. P. M. Matsler*¹, H. D. Chapman¹, and M. W. Lavorgna², ¹Department of Poultry Science, University of Arkansas, Fayetteville, ²Alpharma.

The effect of salinomycin and roxarsone upon broilers infected with *Eimeria* species during the starter phase (18 days of age) or grower phase (35 days of age) of production was investigated. Birds medicated for 6 weeks and infected during the grower phase produced fewer oocysts than birds medicated for 4 or 5 weeks whether infected during the starter or grower phase. Feed conversion at 6, 7 and 8 weeks of birds infected during the starter phase was lower if medicated for 6 rather than 4 or 5 weeks. Feed conversion of birds infected during the grower phase was less if medicated for 6 rather than 5 weeks. It is concluded that medication beyond 5 weeks may be advantageous whether birds are exposed to infection during the starter or grower phase of production.

Key Words: Anticoccidial Drug, *Eimeria*, Broiler

125 Evaluation of an exogenous enzyme (Avizyme®) as feed additive to enhance immunity against *Eimeria* spp and replace antibiotics and ionophores in broiler diets. J. Parker*¹, S. Clemente-Hernandez¹, J. Remus², E. Pierson², B. Clack¹, and E. O. Oviedo-Rondón¹, ¹Stephen F. Austin State University, Nacogdoches, TX, ²DANISCO Animal Nutrition, St. Louis, MO.

Changes in gut microflora and crude protein levels have been linked to enhance immunity against coccidia. The objective of this trial was to evaluate the utilization of a combination of amylase, protease, and xylanase designed for corn-soybean meal diets (Avizyme® 1502) as a feed additive to enhance immunity against coccidia, and replace antibiotics and ionophores in broiler starter diets with different levels of crude protein. This trial was conducted in Petersime brooding units with 504 day-old male Cobb-500 chickens distributed in 72 cages. Twelve treatments as a result of a 3 x 3 factorial, plus 3 negative controls (No additives-No challenge) within each protein level were distributed. Crude protein levels (19, 21, 23%) and anticoccidial control program (Cocci-Vaccine, Antibiotic + Ionophore, and Vaccine+Enzyme) were evaluated as main effects in the factorial. All chickens, but those in the negative and positive control (antibiotic + ionophore) treatments were vaccinated at 1 d of age with Advent® vaccine. All chickens, but those in negative control treatments were challenged at 17 d of age with a mixed oral inoculum of *E. acervulina*, *E. maxima*, and *E. tenella*. Lesion scores and oocyst counts were evaluated at 24 d of age. Body weight and feed intake were recorded at 17 and 24 d. Feed conversion ratio was determined and corrected by mortality weight. Significant differences ($P < 0.05$) due to the interaction crude protein x anticoccidial program were observed in post-challenge FI and BWG. Crude protein levels affected ($P < 0.01$) BW, FCR in pre- and post- challenge periods. Anticoccidial programs affected ($P < 0.05$) BW at 17 d, BW, FI and FCR at 24 d. The enzyme product improved BW in vaccinated birds at 19 and 21% crude protein diets, but not at 23% CP. Lesion scores were affected ($P < 0.05$) by anticoccidial programs. Vaccinated chickens fed diets with enzyme had the lowest lesion scores in the caecum, while the antibiotic+ionophore group had the lowest lesion scores in midgut. Enzyme may help in responses against coccidiosis, especially by *E. tenella*, and this response is dependent upon dietary protein level.

Key Words: Enzyme, Coccidia, Protein

126 Enhancement of homologous vaccination to *Eimeria acervulina* via CpG-ODNs. K. Ameiss*¹, J. El Attrache¹, A. Barri¹, A. McElroy², and D. Caldwell¹, ¹Texas A&M University, College Station, ²Department of Animal and Poultry Sciences, Virginia Tech, Blacksburg.

Synthetic oligodeoxynucleotides containing CpG motifs (CpG-ODN) have been demonstrated to be effective oral mucosal adjuvants in mice. Recent studies in chickens have shown that CpG ODNs can improve the immune response to protein antigens as well as pathogens. The goal of this study was to determine whether oral administration of a single dose of CpG-ODNs could increase the efficacy of trickle vaccination to a homologous challenge with *Eimeria acervulina* (EA). Chicks were immunized with 500 oocysts of EA strain #12 per day from days 1 to 5

post hatch with and without 50 µg of CpG-ODN or a control non-CpG ODN. They were then challenged with 1.25 X 10⁴ oocysts of the same strain on day 19 post hatch. Body weight and feed consumption were measured on days 12, 19, and 25. Lesions scores were taken on day 25. Mean feed conversion ratios (grams feed consumed/gram gain) during the immunization period, days 1-12, revealed that both the CpG and non-CpG treated groups had significantly lower ($P < 0.001$) feed conversion ratios (2.9 ± 0.14 and 3.1 ± 0.14 , respectively) than the vaccination only group (3.5 ± 0.12). Mean feed conversion ratios during the challenge period, days 19-26, revealed that all immunized groups, CpG, non-CpG and vaccination only (2.05 ± 0.06 , 2.08 ± 0.10 , and 2.19 ± 0.05 , respectively), were significantly lower ($P < 0.001$) than the unimmunized birds (2.4 ± 0.09). Mean lesion scores also revealed a significant difference ($P < 0.001$) between groups receiving either CpGs or non-CpGs (0.40 ± 0.09 and 0.52 ± 0.09 , respectively), immunization only (0.81 ± 0.07), and unimmunized (2.21 ± 0.12) birds. These findings indicate that a single oral administration of CpG ODNs can improve protection from a homologous challenge of *Eimeria acervulina*, improving feed conversion ratio during immunization and reducing lesion score upon challenge.

Key Words: *Eimeria acervulina*, Immunization, CpG-ODNs

127 Egg characteristics of commercial egg laying hens between 20 and 58 weeks of age when inoculated with the S6-strain of *Mycoplasma gallisepticum* 10, 22, or 45 weeks of age. E. Y. Basenko¹, S. W. Park*¹, E. D. Peebles¹, S. L. Branton², D. V. Maurice³, S. K. Whitmarsh¹, and P. D. Gerard⁴, ¹Department of Poultry Science, Mississippi State University, Mississippi State, ²USDA-ARS, SCPL, Mississippi State, MS, ³Clemson University, Clemson, SC, ⁴Experimental Statistics Unit, Mississippi State University, Mississippi State.

The effects of S6-strain *Mycoplasma gallisepticum* (S6MG) inoculation and its timing on egg characteristics were investigated using a total of 160 Hy-Line W36 hens in each of two trials. In each of 16 biological isolation units 10 birds were housed, with four replicate units in each of four treatments. Control birds received sham inoculations at 10 wk of age and treated birds received S6MG inoculations at 10, 22, or 45 wk. Egg weight (EW) was determined weekly between 21 and 60 wk in Trial 1, and between 21 and 53 wk in Trial 2. Eggshell weight per unit of surface area (SWUSA), percentage egg yolk (PY), albumen (PA), and shell (PSW) weights, and yolk moisture (YM) and lipid (YL) contents were determined at 24, 32, 43, 47, and 58 wk, whereas yolk cholesterol (YCHOL) and fatty acid (YFA) contents were determined at 47 and 58 wk in both trials. Hen age influenced EW, PA, PY, PSW, YM, YL and YFA in both trials, but influenced SWUSA only in Trial 2. EW was increased across 46-60 wk by S6MG inoculation at either 10, 22, or 45 wk in Trial 1, and was decreased across 22-45 wk by S6MG inoculation at 22 wk in Trial 2. In Trial 2, PSW and SWUSA were decreased across 47-58 wk by S6MG inoculation at 45 wk. YL was increased at 58 wk in Trial 1 by 45 wk S6MG inoculation, and was decreased at 24 wk in Trial 2 by 22 wk S6MG inoculation. Across 47-58 wk, the 22 and 45 wk inoculations decreased yolk myristic and oleic acid concentrations in Trial 1, but increased yolk stearic and arachidonic acid concentrations in both trials. S6MG inoculation during production may increase egg weight, decrease eggshell quality, and influence yolk total lipid and fatty acid contents during post-peak production.

Key Words: Egg Characteristics, Lipid, *Mycoplasma gallisepticum*

128 Reduction of *Salmonella enteritidis* infection by therapeutic administration of *Lactobacillus* probiotic culture. G. M. Nava*¹, C. M. Pixley¹, R. L. Jarquin¹, C. D. Sartor¹, J. L. Vicente¹, G. Tellez¹, A. M. Donoghue², and B. M. Hargis¹, ¹Center of Excellence for Poultry Science, University of Arkansas, ²PPPSRU, ARS, USDA, Fayetteville, AR.

These studies evaluated the therapeutic effect of a *Lactobacillus* probiotic culture (LPC) producing bacteriocin-like inhibitory substances on *Salmonella enteritidis* PT-13a (SE) infected chicks. All chicks were challenged at day of hatch with approximately 10³ CFU of SE orally, and 2 hr later were randomly assigned to floor pens (n=40) and treated.

Treatments were control group (CG), *Lactobacillus casei* probiotic culture (LCa), *Lactobacillus cellobiosus* probiotic culture (LCE), combination of *L. casei*-*L. cellobiosus* (LCC) and probiotic culture that contained 11 *Lactobacillus* spp isolates (L11). Groups LCa, LCE, LCC and L11 received 10^6 cfu/ml of drinking water; CG received tap water only. Twenty chicks per group were killed at 24 and 72 h post-challenge and cecal tonsils were aseptically collected for SE isolation. Administration of LPC significantly ($p < 0.05$) reduced SE recovery from chicks when compared to the CG (LCa, 59% and 62% reduction; L11, 94% and 63% reduction, 24 or 72 h, respectively). However, LCC reduced SE recovery by 82% only at 24 h). The design of EXP II was similar with CG, LCa, LCa-10x (107 cfu/ml), L11, and L11-10x. LPC treatment significantly ($p < 0.05$) reduced SE recovery when compared to the CG (LCa, 53% and 41%; LCa-10x, 100% and 100%; L11, 81% and 85%; L11-10x, 82% and 100% reduction at 24 and 72 h respectively). In EXP III, CG, LCa-10x and L11-10x were compared and samples obtained only at 72 h. LPC administration significantly ($P < 0.05$) reduced SE recovery when compared to the CG (LCa-10x 81% and L11-10x 81% reduction). These studies suggest that in addition to their better known prophylactic effects, appropriately selected defined Lactobacilli cultures may be useful for actually displacing *Salmonella* infections.

Key Words: *Salmonella*, Probiotic, Lactobacilli

129 Experimental induction of tibial dyschondroplasia in chickens using a short regimen of feeding with thiram. N. Rath*, W. Huff, J. Balog, and G. Huff, *USDA, ARS, Poultry Science Center, University of Arkansas, Fayetteville.*

Tibial dyschondroplasia (TD) is characterized by the presence of a plug of unresolved cartilage in the growth plate that fails to form bone. Because the etiology of the naturally occurring TD is unknown, it has been difficult to determine the mechanisms of its pathogenesis. Naturally occurring lesions have limited potential to provide insight into the initiation and the progression of TD. The objective of our study was to develop an experimental model that can help understand the mechanisms of TD and should be amenable to screen for the factors that may protect against the disease. To address this objective we tested whether it is feasible to induce TD using a short duration of feeding with thiram, a fungicide. One wk-old-broiler chickens were fed diets containing 0-100 ppm of thiram for 24-48 h and the growth plates were examined for the presence of TD at the end of treatment or 5, 12, and 17 days after feeding. The lesions were given an evaluation score ranging from 0 (none) to 1 (moderate), and 2 (severe) based on growth plate width. The results showed that as little as 10-20 ppm of thiram fed for only a 24 h period increased the incidence TD which was augmented as the concentration was raised up to 100 ppm where most chickens were affected with severe TD. The TD index (severity x incidence) showed to plateau with 100 ppm of thiram fed for 48 h. A dose of thiram between 80-100 ppm appeared reasonable to study the early changes leading to TD. Under this condition the growth plate showed little visual demarcation at 48 h after feed treatment but sustained a progressive pathogenesis of TD during subsequent periods with both morphological and histological changes in spite of the fact that the birds no longer received thiram. There was no cell division in the maturing zone cartilage but an accumulation of chondrocytes with many cells showing nuclear blebbing, and shrinkage was accompanied by an extensive degeneration of blood capillaries. We conclude that this optimized protocol to induce TD by short feeding of thiram or similar compounds may be valuable to understand the initiation and progression of TD and to develop screening methods for its control.

Key Words: Tibial Dyschondroplasia, Thiram, Chicken

130 *Salmonella typhimurium* Felix-O1 and P22 bacteriophage host range and viability under gastrointestinal conditions. P. Herrera*, E. M. Kozhina, and S. C. Ricke, *Texas A&M University, College Station.*

Salmonella typhimurium is both a human and veterinary health problem. The traditional method of control is the use of antibiotics as a feed supplement. However the increased rate of antibiotic resistance has for alternative methods. Bacteriophage have several advantage over antibiotics including being host specific and self replicating. However, in order to use phage, it must be able to survive potential denaturation in the gastrointestinal tract. The purpose of these experiments are to test the

stability of two phage specific to *Salmonella typhimurium* under conditions they would encounter in the gastrointestinal tract. Felix-O1, a lytic bacteriophage that infects most smooth phenotypes of *Salmonella*, was tested along with P22, a temperate *Salmonella* phage. Phage lysates (10 μ l) with concentrations of 10^5 PFU/ml were spotted on lawns of 10 strains of *Salmonella typhimurium*. Felix lysed 7 of the 10 strains as compared to P22 which only lysed 4 strains. Felix was able to infect *Salmonella typhimurium* strains ATCC 14028, ATCC 13311, UK-1 and serovars Javiana, Muenchen, Rubislaw, and Texas. To test the stability of phage under environmental conditions seen in the cecum of a chicken, 1 ml of a Felix-O1 suspension (10^9 PFU/ml) was dispensed in tubes containing 5 ml of 1:100 dilution of cecal contents and 0.25 g of ground alfalfa. The tubes were incubated at 37°C under anaerobic conditions for 1, 3, 6, 12, and 24 hours at which times phage concentration was titrated using the soft agar overlay method. Within one hour of incubation, the phage was reduced below measurable levels. Felix-O1 suspension (1 ml) was added to 1 ml of a pepsin solution (32,100 units/ml) and incubated with agitation at 37°C for three hours. Addition to the acidic proteinase solution produced an decrease in phage viability of six orders of magnitude. Pepsin produced only a modest decrease in phage numbers over the 3 h period. These results suggest that Felix-O1 might be an effective anti-*Salmonella typhimurium* agent if its stability under gastrointestinal condition can be improved.

Key Words: *Salmonella*, Bacteriophage, Gastrointestinal

131 Rapid detection of infectious bursal disease virus using one-step RT-PCR in clinical samples in Pakistan. M. A. Zahoor*¹, I. Hussain¹, M. K. Mansoor¹, S. Masood¹, and Q. M. Khan², ¹University of Agriculture, Faisalabad, Pakistan, ²NIBGE, Faisalabad, Pakistan.

A SuperScript One-Step reverse transcriptase polymerase chain reaction (RT-PCR) technique was used for the detection of infectious bursal disease virus in clinically affected bursal tissue specimens. The viral RNA was isolated using TRIzol One-step RNA isolation kit (LS Reagent, Life Technologies). A set of primers was used that amplified a 743-bp fragment of VP2 gene hypervariable region from the nucleotides 701 to 1444. An amplified fragment was found in 21 samples out of 26 whereas none was obtained in case of unrelated virus or IBDV negative samples. Results showed that SuperScript One-Step RT-Taq system can be used for the rapid detection of IBDV in tissue specimens.

Key Words: One STEP RT-PCR, IBDV, Pakistan

132 Very virulent strains of infectious bursal disease virus in Pakistan. M. A. Zahoor*¹, I. Hussain¹, M. K. Mansoor¹, S. Masood¹, and Q. M. Khan², ¹Faculty of Veterinary Science University of Agriculture, Faisalabad, Pakistan, ²NIBGE, Faisalabad, Pakistan.

Nine bursa samples were collected from a severe outbreak of infectious bursal disease in two commercially reared broiler farms in Oct 2003. The gross lesions particular of IBD and the presence of high mortality speculated the presence of very virulent strains of infectious bursal disease virus (IBDV) in Pakistan. The bursa samples were subjected to reverse transcriptase-polymerase chain reaction (RT-PCR) and restriction fragment length polymorphism analysis. A primer pair that amplified a 743-bp fragment from the nucleotides 701-1444 was used. Seven bursa samples were found to contain the IBDV. The PCR product was further digested with SspI restriction enzyme to identify the very virulent phenotype. Results indicated that three of the tested bursa samples were SspI positive i.e. vvIBDV. This first report describes that there exist vvIBDV strains in Pakistan and SspI restriction enzyme could be used as virulent marker.

Key Words: Very Virulent Strains, IBDV, Pakistan

133 RT-PCR Based diagnosis of infectious bursal disease virus in Pakistan. M. A. Zahoor*¹, I. Hussain¹, M. K. Mansoor¹, S. Masood¹, and Q. M. Khan², ¹University of Agriculture, Faisalabad, Pakistan, ²NIBGE, Faisalabad, Pakistan.

A total of 26 bursa samples collected from different outbreaks of infectious bursal disease, were tested at Molecular Virology Lab (EBD, NIBGE, Faisalabad) for the presence of infectious bursal disease virus using a highly sensitive method i.e. reverse transcriptase polymerase

chain reaction (RT-PCR). Viral RNA was extracted from the bursal tissue samples using Proteinase K digestion method. A 5 ug of the viral RNA was used for the synthesis of cDNA using RevertAid TM First Strand cDNA Synthesis Kit (MBI, Fermentas). The VP2 hypervariable region of the IBDV was amplified using specific primers. A single band

of PCR product of the expected size was visualized on 1.5% agarose gel after ethidium bromide staining. Results indicated that PCR is a sensitive method for the rapid detection of IBDV.

Key Words: RT-PCR, IBDV, Pakistan

PSA-Physiology: Poultry Digestion and Metabolism

134 Compromised liver mitochondrial function and complex activity in low feed efficient broilers associated with higher oxidative stress and differential expression of proteins within a single male line. M. Iqbal*¹, N. R. Pumford¹, Z. X. Tang¹, K. Lassiter¹, W. Bottje¹, T. Wing², and M. Cooper², ¹University of Arkansas, Fayetteville, ²Cobb-Vantress, Inc., Siloam Springs, AR.

Two experiments were carried out to determine the relationships of; a) mitochondrial function and activities of various complexes, b) production of reactive oxygen species (ROS) and its subsequent effect on protein oxidation, and c) protein expression in liver of male broilers with low and high feed efficiency (FE, n =5-8 per groups). Mitochondrial function and complex activities were measured polarographically and spectrophotometrically, respectively. Hydrogen peroxide (H₂O₂) was measured fluorometrically, while oxidized protein (carbonyls) and immunoreactive mitochondrial proteins were analyzed using Western blots. Mitochondrial function (ETC coupling) and activities of all respiratory complexes (I, II, III, IV) were higher in high FE compared to low FE broilers. H₂O₂ and protein carbonyls were higher in the liver of low compared to high FE broilers. Whereas the expression of four immunoreactive proteins [NAD3 (Complex I), QPC (Complex III), COX II and COX IVb (Complex IV)] were higher in low FE liver mitochondria and two proteins [70S (Complex II) and alpha-ATPase (Complex V)] were higher in high FE birds, there were no differences between groups in the expression of 18 other respiratory chain proteins. SDS-PAGE revealed several proteins (ranging from 20 to 180 kDa) that were differentially expressed between the low and high FE groups. In conclusion, taken together with our previous findings in breast muscle (Iqbal et al., 2004, Poult. Sci. 83:474-484), the differential expression of certain mitochondrial proteins might be a compensatory response aimed to maintain the compromised respiratory chain activity and/or to overcome the increased protein oxidation in low FE birds. Funded in part by USDA-NRI grant (#2001-03443).

Key Words: Feed Efficiency, Mitochondrial Complex Activity, Oxidative Stress

135 Membrane potential and hydrogen peroxide production in duodenal mitochondria in broilers with low and high feed efficiency. C. Ojano-Dirain*¹, N. Tinsley¹, M. Iqbal¹, T. Wing², M. Cooper², and W. Bottje¹, ¹University of Arkansas, Fayetteville, ²Cobb Vantress Inc., Siloam Springs, AR.

Increased hydrogen peroxide (H₂O₂) production was observed in duodenal mitochondria obtained from broilers with low feed efficiency (FE). As a decrease in mitochondrial membrane potential (MMP) due to stimulation of uncoupling of oxidative phosphorylation reduces reactive oxygen species (e.g., H₂O₂) production, this study was conducted to evaluate the effect of uncoupling on MMP and H₂O₂ production in duodenal mitochondria from broiler breeder males with low and high FE. Duodenal mitochondria were isolated from broilers with low (0.48 ± 0.02, n = 8) and high (0.68 ± 0.01, n = 7) FE. H₂O₂ production and membrane potential were measured fluorometrically using dichlorofluorescein and tetramethylrhodamine methyl ester probe, respectively, in the presence of different levels (0, 200, 400, 600, 800 and 1,000 nM) of an uncoupler, carbonylcyanide p-trifluoromethoxyphenylhydrazone (FCCP). The MMP was higher (P < 0.05) in the high FE mitochondria at 0 to 600 nM FCCP. A decrease in MMP was observed at 600 and 800 nM FCCP for the low and high FE groups, respectively. H₂O₂ generation was higher in the low FE mitochondria at all FCCP levels except at 200 nM. Adding 200 to 800 nM FCCP caused a decrease in H₂O₂ production in low but not in high FE mitochondria. The results indicate that FCCP-induced uncoupling lowered H₂O₂ production in low FE but not in high FE duodenal mitochondria and indicate that mitochondrial membrane

potential may influence reactive oxygen species production in broilers with low FE. Supported in part by USDA-NRI #2001-03443.

Key Words: Feed Efficiency, Duodenal Mitochondria, Membrane Potential and H₂O₂ Production

136 Evidence of protein oxidation in mitochondrial respiratory complexes in broilers with low and high feed efficiency. J. P. Higgins*¹, N. R. Pumford¹, M. Iqbal¹, T. Wing¹, M. Cooper¹, and W. G. Bottje¹, ¹Department of Poultry Science, University of Arkansas, Fayetteville, ²Cobb-Vantress, Inc., Siloam Springs, AR.

We have observed increased mitochondrial radical production, increased protein oxidation and lower activities of respiratory chain complexes in broilers with low feed efficiency (FE) compared to broiler breeders with high FE. As radical-mediated protein damage could cause the reduction in complex activities, the purpose of this experiment was to determine if there is evidence of protein oxidation that is specifically associated with respiratory chain complexes. Mitochondria were isolated by differential centrifugation from breast muscle obtained from broiler breeder males identified as either low (0.62 ± 0.01, n = 8) or high (0.80 ± 0.01, n = 8) FE. Respiratory chain complexes were separated using a non-denaturing gradient polyacrylamide blue native gel. Protein carbonyl levels were measured with an immunochemical assay in which proteins are reacted with 2,4 dinitrophenylhydrazine to produce a corresponding hydrazone. The hydrazone is then detected by Western analysis using anti-dinitrophenyl antisera. Preliminary results indicate that Low FE mitochondria exhibited higher levels of protein carbonyls (indicating increased protein oxidation) in Complex III compared to levels in High FE mitochondria. These findings suggest that increased protein oxidation may be responsible in part for the lower respiratory chain activities observed in broilers with Low FE. Further research is being conducted to ascertain protein oxidation in other mitochondrial complexes and other mitochondrial proteins in relation to the phenotypic expression of feed efficiency in broilers. Supported in part by USDA-NRI (#2001-03443).

Key Words: Feed Efficiency, Protein Oxidation, Blue Native Gel Electrophoresis

137 Dietary phytates may noncompetitively inhibit intestinal mucosa phytase in broiler chicks. E. M. Onyango*¹, E. K. Asem², J. S. Sands³, and O. Adeola¹, ¹Department of Animal Sciences, Purdue University, West Lafayette, IN, ²Basic Medical Sciences, Purdue University, West Lafayette, IN, ³Danisco Animal Nutrition, Marlborough, Wiltshire, UK.

The role of dietary phytate in the regulation of intestinal mucosa phytase was investigated in broiler chicks. One hundred and eight 7-d-old male broiler chicks were grouped by weight into six blocks of 3 cages with six birds per cage. Three chemically defined diets were randomly assigned to cages within each block. The three diets were a chemically defined casein diet; chemically defined casein diet plus sodium phytate (20 g/kg diet), and a chemically defined casein diet plus sodium phytate (20 g/kg diet) and microbial phytase (1000 U/kg diet). The chicks were fed experimental diets from 8 to 22 d of age. At the end of the study, chicks were weighed, killed, and duodenal mucosa and left tibiae removed. Tibiae were defatted and ashed overnight at 600 °C. Phytase activity in brush border vesicles prepared from the duodenal mucosa was determined by measuring the amount of inorganic phosphorus released from sodium phytate. Addition of phytate to the chemically defined diet reduced (P < 0.05) weight gain, feed intake, feed efficiency and percentage ash. However, addition of microbial phytase fully restored (P < 0.05) feed efficiency but weight gain was only partially restored (P < 0.05). Addition of phytate to the chemically defined diet reduced (P

< 0.05) the V_{max} of the intestinal mucosa phytase but the K_m of the enzyme was not affected. By comparison, the addition of microbial phytase to the diet did not restore the V_{max} . Phytate may noncompetitively inhibit intestinal mucosa phytase.

Key Words: Broiler Chick, Intestinal Phytase, Microbial Phytase

138 Absorption of 2-hydroxy-4(methylthio) butanoic acid (HMTBA) (5-50mM) is equal to or greater than d,l-methionine (DLM) uptake in chicken intestinal slices. J. D. Richards*, C. Atwell, and J. J. Dibner, *Novus International, Inc., St. Louis, MO.*

The rates of intestinal HMTBA vs. DLM absorption have been controversial. DLM is absorbed mostly by active transport; HMTBA uptake is mainly by diffusion. *In vitro* membrane vesicle systems under-represent diffusion and, therefore, HMTBA uptake. Here, everted rings of chicken jejunum and ileum were used. Cobb broilers were grown on corn-soy diets supplemented with equimolar amounts of HMTBA (Alimet® feed supplement, Novus International, Inc.) and DLM (0.1% each). Birds (day 13-30) were sacrificed, and their intestines sliced into rings and everted. Sections were cultured at 37°C at pH 7 for 0.5 min, 1 min, 1.5 min, 2 min or 5 min in the presence of glucose; KCl or NaCl (to test Na-dependence); and 5, 10, 20 or 50mM 14C-HMTBA or 14C-DLM (both 2.5 μ Ci/100 μ mol). 3H-inulin (0.5 μ Ci/ml) was included (non-specific binding control). Slices were rinsed and scintillation counted. 3H-corrected HMTBA and DLM counts were calculated, and absorption of HMTBA or DLM per mg of tissue was determined (SAS, LSMEANS). No source by ion interactions existed, so KCl and NaCl data were combined. Absorption of each source was time and concentration dependent. In general, HMTBA uptake was equal to or greater ($P < .05$) than DLM uptake. The exception was at 1.5 minutes, where 5mM DLM absorption (ileum) was greater than 5mM HMTBA (jejunum) ($P < .05$). At 5 minutes, however, absorption of 5mM DLM (jejunum) was less than that of HMTBA or DLM absorption (ileum). No other significant differences existed at 5mM. At 10mM, absorption of HMTBA (ileum) was greater ($P < .05$) than that of DLM (jejunum or ileum), but there were no significant differences between HMTBA (jejunum) and DLM (either tissue). At 20mM and 50mM, absorption of HMTBA in both tissues was greater than or equal to DLM absorption at all time points. In contrast to data from *in vitro* membrane vesicles, this study provides further evidence that HMTBA availability is not limited by intestinal absorption.

Key Words: 2-Hydroxy-4(Methylthio) Butanoic Acid, Methionine, Absorption

139 Isolation and partial characterization of pancreatic alpha-amylase in turkey. E. Blair*, J. Firman, and S. Zhang, *University of Missouri, Columbia.*

White nicholas tom turkey α -amylase was purified by $(NH_4)_2SO_4$ fractionation, dialysis against a $C_2H_3O_2Na$ gradient, and β -cyclodextrin affinity chromatography from an aqueous pancreatic extract. The effects of pH and temperature on amylolytic activity were studied. The ideal pH for pancreatic amylase was determined to be approximately 5.9, with a conservative range of 5.7 to 6.2. The optimal range of temperature was determined to exist between 20 and 30 degrees Celsius. The homogeneous mixture was subjected to SDS-PAGE to determine approximate molecular weight. A 10 kD protein marker was used as a standard. The approximate molecular weight of the amylase was determined to be 40 kD. Isoelectric focusing with a pH gradient of 5 to 8 was run to determine if any isozymes exist. From the IEF it was determined that at least 2 isoforms exist for pancreatic amylase in the turkey.

Key Words: Turkey, Amylase, Digestive Enzymes

140 Unique responses of pancreatic phospholipid metabolism of broiler hens in response to increased plasma glucose and lipid concentrations. S.-E. Chen*¹, R. L. Walzem¹, and J. P. McMurtry², ¹Department of Poultry Science, Texas A&M University, College Station, ²ARS Growth Biology Laboratory, Beltsville, MD.

Higher caloric intake (twice the recommended 145 g/day/hen; T or free access to feed; F, n=15 for each) for 10 days in broiler hens (Cobb 500 Fast Feathering, age=35 wks) caused 500 grams body weight (BW) gain when compared with hens consuming recommended feed intakes (R, n=15) or with hens necropsied at the start of feeding trial as basal references (BR, n=15). Rapid BW gain was associated with an increase ($p \leq 0.05$) of relative liver (50%) and abdominal fat weights (30%), and elevated preprandial plasma insulin (45-60%), NEFA (40%), glucose (43%), VLDL-TG (27%), and total cholesterol (TC) concentrations (60-80%) but a decreased HDL-TC (45%) concentration, suggesting metabolic dysregulations similar to those of mammalian obesity and type-II diabetes. Higher caloric intake also increased ($p \leq 0.05$) relative pancreas weight (25-30%), pancreatic protein content (25%) and protein/DNA ratio (20%), and all classes of pancreatic phospholipids (average 35%), indicative of pancreatic hypertrophy. Notably, phosphatidylethanolamine increased 75% in concert with increased D9 desaturase activity (18:1n9/18:0, mol/mol) (15-30%) and a general enhancement of unsaturation in pancreatic PL fatty acids (12-35%) ($p \leq 0.05$) when compared with group R and PR hens. These observations indicate that specific changes in pancreatic lipid metabolism accompany the acceleration of endocrine/exocrine functions in response to food intake above the amount needed for optimal egg production. Hen pancreatic cells may mount specific metabolic responses to prevent cytotoxicity resulting from excessive glucose and saturated fatty acid availability.

Key Words: Pancreas Phospholipids, Hypertrophy, Lipotoxicity

141 Efficacy of injected gluconeogenic supplementation on the performance of broilers from young breeders. E. D. Peebles*¹, W. D. Berry², R. W. Keirs³, L. W. Bennett³, and P. D. Gerard⁴, ¹Department of Poultry Science, Mississippi State University, Mississippi State, ²Department of Poultry Science, Auburn University, Auburn, AL, ³College of Veterinary Medicine, Mississippi State University, Mississippi State, ⁴Experimental Statistics Unit, Mississippi State University, Mississippi State.

It has been reported that gluconeogenic supplementation using hydrolyzed casein augmented the early performance of broilers from a single young breeder flock at 29 wk of age. In an effort to further explore this concept and determine the efficacy of various other practical nutrient sources, injections (0.2 mL) containing physiological saline or a gluconeogenic energy source (casein hydrolysate, ovalbumin hydrolysate, or crude ovalbumin) were given subcutaneously (in the back of the neck) to 320 broiler chicks at hatch. Concentrations of gluconeogenic substances in solution were approximately 200 g / L. Biotin was added to injected crude ovalbumin solutions. Chicks were hatched from eggs that were obtained from a single young breeder flock at 27 weeks of age. At hatch, chicks were divided into 16 floor pens with 20 chicks in each of four replicate pens per treatment group, and were brooded under commercial conditions. Tissue condition at the site of injection, growth, feed consumption, feed conversion, water intake, livability, and liver weight were determined through 16 days post hatch. Treatment injection caused no local histological reaction. Body weight and relative liver weight at Day 16 were not affected by treatment. Furthermore, daily mortality, and average feed consumption, feed conversion, water consumption, and BW gain per bird over the entire 16 day period and at various shorter consecutive intervals were not affected by treatment. In this study, the use of injected casein hydrolysate, ovalbumin hydrolysate, or crude ovalbumin for gluconeogenic supplementation did not affect the performance of chicks from young parents that were provided adequate brooding conditions.

Key Words: Broiler, Chick, Gluconeogenesis

142 Carcass scratches and growth rate of microwave toe-treated broiler chickens. B. Wang*¹, J. L. MacIsaac², and B. M. Rathgeber¹, ¹*Nova Scotia Agricultural College, Nova Scotia, Canada*, ²*Atlantic Poultry Research Institute, Truro, Nova Scotia, Canada*.

Lighting programs that provide longer daylength as a broiler ages reduce the incidence of ascites and sudden death syndrome. Birds given this type of program often have an increased incidence of carcass scratches due to increased bird activity. The turkey industry uses microwave technology to restrict claw growth and reduce carcass scratches. One concern is that the treatment may reduce bird growth rate. The objective of this study was to determine if microwave toe-treatment would reduce growth rate of chickens if used to reduce carcass scratches for broilers on an increasing photoperiod program. Two replicate trials were conducted with 728 female and 728 male broilers in each trial. Half of each sex was toe-treated using microwave energy upon delivery from the hatchery. The birds in each trial were randomly assigned to four rooms with 8 pens per room. Two rooms were given 23 h of light per day from start to finish and the other two rooms were on a lighting program with short daylength after the first three days, which increased to 23 h by day 31. Light intensity was the same for each lighting program. For half the pens, the bird's growth rate was measured by catching and weighing each bird in the pen on day 7, 14, 24, 31. On day 38, the birds from all the pens were removed and weighed. For six pens per room, computerized bird scales were installed to continually monitor bird weight. Five birds per pen were shipped for slaughter and carcass scratches monitored. Toe-treatment reduced carcass scratches for both lighting programs of which increasing photoperiod had the higher incidence ($p < 0.05$). Based on the traditional weighing method, toe-treatment reduced bird weight on day 14 and 31 ($p < 0.05$). The computerized scales indicated that the toe-treated birds were lighter on day 14 and 24. For both sources of bird weight, the birds given an increasing photoperiod were lighter than those with continuous light on day 7, 14, 24 and 31 ($p < 0.05$). On day 38, there were no lighting and toe-treatment effects ($p > 0.05$). Collectively, the present results demonstrated that microwave toe-treatment and the increasing lighting program didn't influence body weight of broiler chickens at market age.

Key Words: Microwave Toe-Treatment, Lighting Program, Scratches

143 Effect of lighting and handling technique on breast fillet dimensions and meat quality. N. A. McKee*¹, R. J. Lien², J. B. Hess², S. F. Bilgili², and S. R. McKee*², ¹*Auburn University*, ²*Auburn University*.

This study was designed to determine the effect of lighting and handling on growth and meat quality factors. Male Ross 508 broilers (total $n=1050$) were housed in light-tight rooms and subjected to step-up lighting of either, bright (15.0 foot-candles) or dim (0.1 foot-candles). Within these lighting treatments, birds were further divided into 3 handling groups by the legs (L), wings (W), or no handling (NoH) at days 37 and 44 (20 sec. at each age) to determine the effect of handling on the incidence of deep thigh bruises and deep pectoral myopathy (DPM). Birds were reared to 51 d of age. After birds were processed and chilled, a sample of 288 birds were further divided into 2 groups based on deboning time post-mortem (PM). Breast fillets were deboned at 2 h and 4 h PM and fillet weights, fillet dimensions (length, width, and height), cook-loss, and tenderness were evaluated. Shear values were measured using a (TA.XT2i) Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/ UK). Birds subjected to dim lighting had greater live weights ($P < 0.05$), post-chill weights, and fillet weights compared to birds reared in bright light. The increase in fillet weights observed for the dim light treatment was likely due to an observed increase in fillet length, as all other fillet dimensions were similar regardless of lighting or handling. The incidence of DPM and other carcass defects did not vary among the handling or lighting treatments. Cook-loss was affected by a light by handling interaction with the greatest percentage cook-loss observed in the fillets from the bright light NoH, dim light L, and dim light W ($P < 0.05$) compared to other groups. Fillets deboned at 2 h PM had higher shear values than those deboned at 4 h PM, regardless of lighting or handling. Within the 2 h PM deboning period, dim lighting resulted in an increase in shear values compared to bright light treatments. This trend was not observed in the fillets deboned at 4 h PM.

In conclusion, dim lighting treatment resulted in greater bird and fillet weights but slightly tougher meat when fillets were deboned at 2 h PM.

Key Words: Lighting, Handling, Meat Quality

144 Meat quality evaluation of minimally aged broiler breast fillets from five commercial genetic strains. J. M. Mehaffey*¹, J. L. Emmert¹, J.-F. C. Meullenet¹, S. R. McKee², and C. M. Owens¹, ¹*Department of Poultry Science, University of Arkansas, Fayetteville*, ²*Department of Poultry Science, Auburn University, Auburn, AL*.

A total of 1040 birds from 5 common commercial genetic broiler strains were raised and processed in order to analyze the effect of strain and deboning time on meat quality. The birds were processed at either 6 or 7 weeks of age in two replications each. Replications consisted of 26 birds of each strain deboned at 2 h postmortem (PM) and 4 h PM. Carcass and breast weights were measured on each bird in order to calculate breast yield. Fillets deboned at 4 h PM were then measured for length, width, and height at 3 points along the fillet to evaluate footprint analysis. At time of deboning, the caudal tip was taken from one fillet per bird for muscle pH determination using the iodoacetate method. Fillets were individually bagged and stored at 4 C overnight. At 24 h PM, fillets were weighed in order to calculate drip loss, and color ($L^*a^*b^*$) was also measured. The fillets were then cooked to 76 C and cook loss was calculated. One fillet per bird was then subjected to shear analysis using the razor blade shear method where shear energy (N.mm) was calculated in order to evaluate tenderness. The strains in this study were chosen for differences in growth rate and yield; therefore, as expected, breast yield was significantly different among strains. Higher yielding birds exhibited higher shear energy (more tough), higher drip and cook loss, and higher muscle pH when deboned at 2 h PM compared to lower yielding birds. However, at 4 h PM, fewer differences among strains existed in meat quality characteristics (tenderness, water holding capacity, and pH). At 6 and 7 wks, deboning at 2 h PM resulted in higher shear energy, muscle pH, and lower L^* value compared to deboning at 4 h PM in all but one strain. However, water holding capacity was not affected by deboning time at either age interval. Footprint analysis showed that most differences among strains were apparent in heights measured at the fillet midpoint and caudal end. These results suggest that early deboning may impact meat quality of broiler strains differently resulting in greater variation within the industry.

Key Words: Tenderness, Strain, Aging

145 Comparison of Sensory Qualities of Poultry Meat from Alternative Slow-Growing Breeds and a Commercial Breed Grown with or without Outdoor Access. A. C. Fanatico*, P. B. Pillai, L. C. Cavitt, J. F. Meullenet, J. L. Emmert, and C. M. Owens, *University of Arkansas, Fayetteville*.

An experiment was conducted to assess the impact of breed and outdoor access on meat quality of broilers. One slow-growing breed (S), two medium-growing breeds (M1 and M2) and a commercial fast-growing breed (F) were raised for 12, 10, or 8 weeks, respectively, in an attempt to achieve similar body weights. The birds were straight-run, and the placement date was staggered such that all breeds were processed on the same day. Each breed was assigned to three pens of 24 birds each and raised in indoor floor pens; the S and F breeds were also assigned to two floor pens with outdoor access (during daylight hours) containing 36 birds each. All birds were provided with the same starter (0 to 4 weeks for S and M; 0 to 3 weeks for F), grower (4 to 8 weeks S and M; 3 to 6 weeks for F) and finisher (8 to 12 weeks for S; 8 to 10 weeks for M; 6 to 8 weeks for F) feeds. Birds were commercially processed; Pectoralis samples were collected at 6 h postmortem. Thighs were vacuum packed and frozen for 5 months. Consumer panels evaluated breast meat pieces and ground thigh meat patties. There was little difference in texture in breast meat samples among genotypes, although the breast meat from medium-growing broilers was perceived as more tender than breast meat from the fast-growing broilers (indoors) ($P < 0.05$). The thigh meat of the medium-growing broiler (M2) was more intense in flavor than that of the slow-growing broiler (indoor) ($P < 0.05$). The flavor of thigh meat from the medium-growing broilers and the fast-growing broilers was more liked than the slow-growing broilers (indoors) ($P < 0.05$). These data indicate that meat quality differences

may exist among breeds with different growth rates and reared with or without outdoor access.

Key Words: Broiler, Slow-Growing, Free-Range

146 The effect of blood removal, oxidation and shelf-life in broiler meat. C. Z. Alvarado*¹, S. F. O'Keefe², and M. P. Richards³, ¹Texas Tech University, Lubbock, ²Virginia Polytechnic and State University, Blacksburg, ³University of Wisconsin, Madison.

Blood components, especially hemoglobin, are powerful catalysts of lipid oxidation and may cause a decrease in shelf-life of the product. Therefore, this study examined the effect of different slaughter techniques (CO₂ kill and non-bled, no stun and bled, electrical stun and bled, CO₂ stun and bled, and no stun and decapitation) to determine their effect on pH (24 hr), L*a*b* value (24 hr), oxidation, residual hemoglobin concentration (24 hr), and sensory evaluation (day 1 and day 4 postmortem) in the broiler breast fillets. The birds were conventionally processed and analyses were performed at 24 hr PM except residual hemoglobin where the samples were frozen (-80 °C) until analyses (< 2 months). There were no significant differences in pH or b* values at 24 hr postmortem among any of the treatments. L* values were significantly higher indicating lighter fillets in the electrically stunned (56.99) and decapitated birds (56.29) compared to the darker fillets from the CO₂ stunned and bled birds (53.88). The CO₂ kill and non-bled birds (4.18) had significantly higher a* values, indicating more red color, when compared to the electrically stunned and bled (3.09) and decapitated birds (2.80). There were no significant differences in the residual hemoglobin content in the broiler breast muscle when comparing all of the treatments except CO₂ kill non-bled which was significantly higher (10.04). Overall TBARS (raw, cooked 24hr and cooked 72hr PM) indicate that ES and bled had the lowest TBARS when compared to the remaining treatments. Consumer panels detected a difference in both aroma (chicken meaty and warmed-over) and flavor (chicken meaty and warmed-over) at 24 hr PM. However, by 72 hr PM, there were no significant differences in either aroma or flavor. Therefore, different slaughter and bleeding methods may affect color and sensory properties of the broiler breast fillets.

Key Words: Oxidation, Blood Removal, Shelf-Life

147 Dietary supplementation of functional ingredients improves quality of irradiated raw turkey breast. H. Yan*, K. Nam, E. J. Lee, B. Min, K. S. Park, H. Ismail, and D. U. Ahn, Iowa State University, Ames.

The effect of dietary functional ingredients - vitamin E, selenium (Se), conjugated linoleic acid (CLA) - alone or combination on the quality of irradiated turkey breast meat was evaluated. Four hundred eighty male turkeys (12-week-old, raised on a corn-soybean basal diet) were randomly allotted to 32 pens (4 pens/treatment) and fed 8 experimental diets (A, B, C, D, E, F, G, H) supplemented with none (Control, Diet A), 200 IU/kg diet vitamin E (Diet B), 0.3 ppm Se (Diet C), 2.5 % CLA (Diet D), combination of Vitamin E and Se (Diet E), combination of Vitamin E and CLA (Diet F), combination of CLA and Se (Diet G), combination of vitamin E, Se, and CLA (Diet H). At 15-week age, all birds were slaughtered and breast muscle from 8 birds per each pen was separated and grounded. Raw meat patties were either aerobically or vacuum packaged and irradiated using a Linear Accelerator to a dose of 0 or 1.5 kGy absorbed dose. Lipid oxidation, color, and volatile changes of meat were measured after 0 and 7 days of storage at 4 °C. Vitamin E, Se, and fatty acids composition were also determined. Dietary supplementation of vitamin E and CLA increased their deposit in turkey breast. Dietary supplementation of CLA increased monosaturated fatty acids in meat. Irradiation increased ($p < 0.05$) lipid oxidation and hunter color a value, produced specific volatiles such as dimethyl disulfide and hexanal involved in off-odor. Dietary Vitamin E, Se, CLA alone and their combination decreased ($p < 0.05$) lipid oxidation caused by both irradiation and storage. Off-odor volatiles from irradiation were significantly ($p < 0.05$) decreased by dietary functional ingredients. It was concluded that dietary supplementation of functional ingredients improved the quality of irradiated turkey breast meat, lipid oxidation and off-odor caused by irradiation and storage.

Key Words: Dietary Functional Ingredients, Irradiation, Meat Quality

148 Na⁺ migration and quality parameters in turkey fillets using different marination techniques. C. Z. Alvarado*¹ and H. Wang^{2, 1}, ¹Texas Tech University, Lubbock, ²Virginia Polytechnic and State University, Blacksburg.

Marination with salt and phosphate is used as a method of improving quality and extracting salt soluble proteins in turkey meat. However, there are several marination methods available that can affect penetration of marinade and therefore affect meat quality. The objectives of this research were to determine the quality parameters (pH, L* value, marinade pick up (%), marinade retention (%), protein solubility, shear value, cook loss (%), and Na⁺ migration) of the turkey fillet when marinated by several commercial methods. A total of 160 fillets were marinated (20% wt/wt, 94% water, 3.6% NaCl, and 2.4% STP) by multi-needle injection at 4°C, vacuum tumbling (25 mmHg, 4°C, 14 RPM for 1 hour), injection + tumbling or were left as non-marinated controls. There were no significant differences in pH or L* value among the fillets prior to marination. However, by 24 hr post-marination, the pH and L* value of injected + tumbled (6.14, 51.12) and injected (6.13, 50.97) fillets were significantly higher than the control fillets (6.04, 48.91). Injected + tumbled (24.30%) and injected (24.25%) fillets had higher pickup than the tumbled (18.15%) fillets while the tumbled (98.93%) and injected + tumbled (98.23%) had higher retention than injected (95.58%) fillets. There were no significant differences in tenderness, protein solubility or cook loss among any of the treatments. The injected treatment had no differences in sodium ion content throughout the fillets while the injected + tumbled and tumbled treatments had varying levels of Na⁺ migration throughout the fillet. Overall, the injected + tumbled and injected fillets had the highest concentrations of total Na⁺ followed by tumbled and control which were significantly different. Therefore, marination method may affect Na⁺ migration throughout the turkey fillet but this difference may not cause a negative effect on quality.

Key Words: Marination, Sodium, Turkey Fillets

149 Utilizing marination and vacuum tumbling techniques to optimize tenderness of breast fillets deboned early post-mortem. L. J. Bauermeister* and S. R. McKee, Department of Poultry Science, Auburn University, Auburn, AL.

This study was designed to determine the effectiveness of marination, injection marination and/or vacuum tumbling as a means of alleviating the toughness associated with early deboning of breast. Broilers (n=480) 48-60 days of age were conventionally processed. Experimentally, a 2 X 2 X 8 factorial arrangement was used, in which replicates were considered different processing days. Fillets deboned at 2 and 4 h post mortem (PM) were subjected to the following treatments (n=15/treatment): 1. control, 2. tumble (T), 3. marination (M), 4. marination, tumbling (MT), 5. dry injection (I), 6. injection marination, tumbling (IMT), 7. dry injection, tumbling (IT), 8. injection marination (IM). When marinade was applied either by injection or brine-soaked, the marinade pick-up was 10% of the fillet weight to give a final concentration of 0.7% sodium chloride and 0.45% sodium tripolyphosphate per fillet. Biochemical parameters measured (n=80) included pH, sarcomere length, R-value. In addition, cook-loss and shear values were evaluated. Shear values were measured using the (TA.XT2i) Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/Stable MicroSystems, Godalming, Surrey, UK). In the fillets deboned at 2 h PM, injection marination treatments (IMT and IM) decreased cook-loss. In the fillets deboned at 4 h PM, all marination treatments (M, MT, IMT and IM) lowered the cook-loss compared to other treatment groups. At 2 h PM, the injection marination treatments (IMT and IM) lowered shear values compared to shear values of other treatments and the 4 h PM control. Also, in fillets deboned at 4 h PM, the marination treatments (M, MT, IMT and IM) lowered shear values below the 4 h PM control. This study suggests that the use of marination and injection marination could be an effective means of alleviating toughness associated with deboning fillets as early as 2 h PM.

Key Words: Marination, Tenderness, Early Deboning

150 The correlation of razor blade shear, Allo-Kramer shear, Warner-Bratzler shear, and sensory tests to changes in tenderness of broiler breast fillets. L. C. Cavitt*¹, R. Xiong², J.-F. C. Meulenet², and C. M. Owens¹, ¹Department of Poultry Science, University of Arkansas, Fayetteville, ²Department of Food Science, University of Arkansas, Fayetteville.

This study was conducted in order to evaluate the efficacy of the razor blade shearing method and various other instrumental shearing methods (Allo-Kramer and Warner-Bratzler) as a means for developing models for predicting tenderness in broiler breast fillets. Breast fillets were deboned at various times postmortem (0.25 to 24 h) to yield a vast assortment of tenderness levels. Breast fillets were cooked to 76°C and subjected to either shear analysis or sensory analysis (trained or consumer). A trained descriptive panel was used to evaluate samples for attributes including initial hardness and chewdown hardness and a consumer panel for evaluation of attributes including overall acceptability and intensity of tenderness. Relationships between instrumental and descriptive sensory attributes exhibited correlations of $0.53 < R^2 < 0.73$ for initial hardness and chewdown hardness while correlations between instrumental and consumer sensory attributes of acceptability of tenderness and intensity of tenderness revealed coefficient of determination values ranging from $0.71 < R^2 < 0.97$. For both descriptive and consumer sensory analysis, razor blade, Warner-Bratzler, and Allo-Kramer shear tests performed similarly for predicting the tenderness of cooked broiler breast meat. When comparing all three instrumental shearing methods, the razor blade shear test is more advantageous in predicting tenderness as compared to the other instrumental methods due to the fact that no sample cutting or weighing is required in order to execute the test, nor is it excessively destructive as only a small incision (8.9 mm in width) is made in the sample. The razor blade shear test is also advantageous over the other testing methods in that results could be obtained two times as fast as opposed to the other testing methods with very similar or greater precision for predicting tenderness of cooked broiler breast meat.

Key Words: Tenderness, Razor Blade Shear, Sensory

Ruminant Nutrition: Beef - Energy and Nitrogen

152 Blood ketone levels of young postpartum range cows increased after supplementation ceased. R. L. Endecott*, C. M. Black, K. A. Notah, and M. K. Petersen, *New Mexico State University, Las Cruces.*

Young beef cows grazing dormant native range experience weight loss and nutrient imbalances postpartum. Due to high acetate production from ruminal fermentation and low metabolic glucose supply, ruminal acetate is cleared slowly and may be converted to β -hydroxybutyrate (β HB). As a chute-side measure of nutrient status, whole-blood β HB levels of two- and three-year-old postpartum range cows ($n = 45$) were measured with a handheld ketone sensor (MediSense/Abbott Laboratories, Abingdon, UK). Measurements were taken in May and July when cows were grazing dormant range. In May, cows were also receiving one of three 30% CP supplements containing increasing quantities of glucogenic precursors (57, 124, or 192 g/d glucogenic potential). For each ketone reading, β HB in the blood is oxidized to acetoacetate in the presence of hydroxybutyrate dehydrogenase with the concomitant reduction of NAD^+ to NADH. The NADH is reoxidized to NAD^+ by a redox mediator. The current generated is directly proportional to the β HB concentration. After 30 s, the β HB concentration (mmol/L) is displayed on the meter. Data were analyzed using physiological state, time of measurement and their interaction in the model. Cows had higher ($P < 0.01$) β HB in July than they did in May (0.34 vs 0.16 ± 0.02 mmol/L, respectively). Levels of β HB did not approach subclinical ketosis. However, the differences between the two measurements may suggest that the glucogenic precursors in the supplements may have improved utilization of acetate arising from ruminal fermentation. Cows were at an earlier stage of lactation (avg 53 d postpartum), presumably producing more milk, but gaining weight (0.11 ± 0.10 kg/d) in May, while in July were further along the lactation curve (avg 124 d postpartum) and producing less milk, but losing weight (-0.22 ± 0.10 kg/d). Protein sup-

151 Functional analysis of turkey breast muscle. M. S. Updike*¹, M. Lilburn², G. Kaletunc¹, H. Zerby¹, and M. Wick¹, ¹The Ohio State University, Columbus, ²The Ohio State University, Wooster.

Data from recent publications suggest that there is a decrease in turkey breast muscle functionality in further processing. This reduced functionality is hypothesized to be associated with changes in the salt soluble proteins extracted from the breast muscle prior to cooking. To test this hypothesis, salt soluble proteins were extracted from breast muscles obtained from three distinct turkey genotypes. These genetic lines were as follows: 1) the RBC2 line, representative of the 1960s era commercial turkeys; 2) F-line, a subline of RBC2 selected only for 16 week body weight; 3) C-line, representative of present day commercial turkeys selected for body weight and increased breast muscle yield. The rationale for using the three genotypes was to create an extremely variable genetic pool of muscle samples from which to correlate protein composition and functionality relationships. Myosin heavy chain concentrations in the salt soluble protein solutions, as determined by electrophoresis and image analysis, were not different among the genotypes ($P < 0.05$). Rheological analysis was conducted on thermally induced meat gels generated from all the breast muscles sampled ($n=5$ per line). There was a 50-fold difference in the storage modulus (G) between the highest and lowest values obtained from the final step of a programmed temperature ramp from 40°C to 80°C. Breast muscles from the RBC2 line had the highest gel strength at 131 Pa, followed by the F-line (89 Pa), and the C-line (54 Pa; $P=0.09$). A reverse stepwise linear regression analysis was used to associate staining intensities of bands obtained from a 1-D proteomic fingerprint of the salt soluble proteins with the rheological variability observed in the thermally induced meat gel strengths. This analysis showed that two bands were associated with the ultimate gel strength ($R^2 = 0.87$, $P < 0.01$). These findings are unique in showing that variations among the salt soluble proteins, other than myosin, affect the functionality of thermally induced meat gels. Further characterization of these bands will give further insight into the mechanisms underlying the functionality of turkey breast meat.

Key Words: Thermally Induced Meat Gel, Rheology, Proteomic Fingerprinting

plementation may have decreased β HB produced by improving acetate clearance due to a greater supply of glucogenic precursors.

Key Words: Beta-hydroxybutyrate, Acetate, Glucose

153 Effect of step-up program during grain adaptation on ruminal pH and fermentation in feedlot cattle. D. W. Bevens*^{1,2}, K. S. Schwartzkopf-Genswein¹, T. A. McAllister¹, K. A. Beauchemin¹, and J. J. McKinnon², ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, Canada, ²University of Saskatchewan, Saskatoon, SK, Canada.

Effects on ruminal parameters of rapid vs. gradual adaptation to a high concentrate feedlot diet were compared in a completely randomized study ($n = 6$) using 12 ruminally cannulated heifers (384 ± 25 kg BW). The heifers were housed individually and feed was delivered once daily for ad libitum consumption. Dietary transition from 40 to 90% concentrate was accomplished in 3 d using one step-up diet (rapid adaptation, RA) or in 15 d with five step-up diets (gradual adaptation, GA). The initial diet comprised 35% dry-rolled barley, 45% barley silage, 15% grass hay and 5% supplement (DM basis). These ingredients were used to formulate diets containing (DM basis) 48.3, 56.7, 65.0, 73.3, 81.7, and 90% concentrate. For treatment GA, each diet was fed for 3 d; for RA, only the 65% and 90% concentrate diets were fed. Ruminal pH was monitored continuously for 20 d via indwelling electrodes, and ruminal fluid was sampled 8 h after feeding on days of diet change. On days of change to 65 or 90% concentrate, treatment effects on minimum, maximum, or mean pH, or on the area of $pH \times$ time curves falling below 5.6 or below 6.2, were not observed ($P > 0.10$). Over the 3 d following introduction of 65% concentrate diets, the area of $pH < 5.6$ was greater ($P = 0.08$) with RA than with GA. No other effects ($P > 0.10$) of treatment on pH variables were observed during the 3 d of feeding 65% or 90% concentrate diets. Treatment did not affect ($P > 0.10$) total VFA concentrations or ruminal fluid osmolality, but in some samples, acetic

acid concentrations tended to be higher with RA than with GA. Acute acidosis (ruminal pH <5.2 for 10.1 h; 22.8 mM ruminal lactate 8 h after feeding) was observed in one RA heifer upon introduction of the 90% concentrate diet. In this study, recognized indicators of acidosis were only minimally increased by rapid step-up to a high grain diet. However, rapid adaptation to grain may cause acidosis in a small proportion of cattle.

Key Words: Acidosis, Barley, Volatile Fatty Acids

154 A comparison of whole animal energy expenditure by Angus, Holstein, and Wagyu heifers. K. A. Ross¹, C. T. Gaskins¹, J. J. Michal¹, D. H. Keisler², and K. A. Johnson^{*1}, ¹Washington State University, Pullman, ²University of Missouri, Columbia.

Angus, Holstein and Wagyu heifers (N=8/breed; 10 mo) were used to compare and evaluate variation in maintenance energy requirements (ME_m) among and within these breeds. Open-circuit, indirect respiration calorimetry chambers were used to determine heat production (HP) at 3 levels of intake balanced for 0.17 Mcal NEm/kg<.75> (HIGH), 0.13 Mcal NEm/kg<.75> (LOW), and fasting (FAST). A total collection digestion trial was used to determine the digestibility (DE) and metabolizability (ME) of the LOW diet that contained 24% rolled barley, 66% alfalfa hay, and 10% alfalfa haylage (DM-basis). Blood was collected and serum was harvested from heifers at HIGH and LOW intakes for leptin analysis. Assuming a semilog relationship between HP and ME intake (MEI), ME_m was determined by iteratively solving for the point where MEI equals HP. Heifers gained 0.78 ± 0.05 and 0.56 ± 0.04 kg/d when fed HIGH and LOW diets, respectively. The LOW diet contained 68% DE and 57% ME. Methane loss at the LOW intake averaged 7.5 ± 0.2 % of gross energy intake. Angus (113.5 kcal/kg<.75>) and Wagyu (105.2 kcal/kg<.75>) had lower (P<0.01) ME_m requirements than Holstein (137.1 kcal/kg<.75>). Retained energy (RE) was not different among breeds and averaged 61.4 ± 4.7 kcal/kg<.75> at HIGH and 36.7 ± 4.2 kcal/kg<.75> at LOW. Wagyu tended to have slightly higher RE (42.4 kcal/kg<.75>) at LOW intake. There was more variation in ME_m between breeds (72%) than within breed (28%). Serum leptin at HIGH averaged 7.3 ± 0.47 ng/ml and was not different between breeds. Leptin concentrations in Angus and Holstein heifers did not change when switched to the LOW diet, but serum leptin of Wagyu decreased to 3.1 ± 0.47 ng/ml, which was significantly lower (P<0.01) than the other breeds. Serum leptin concentrations were not correlated to ME_m or HP at any level of intake. Growing Wagyu heifers have energy requirements similar to those observed in Angus heifers of the same age.

Key Words: Wagyu, Maintenance Energy Requirements, Leptin

155 Effects of intravenous infusions of acetate, propionate, lactate, or glucose on lipogenic enzyme activity in bovine adipose tissue. J. D. Arseneau*, M. E. Spurlock, J. R. Townsend, L. A. Horstman, and R. P. Lemenager, *Purdue University, West Lafayette, IN.*

The objective of this study was to evaluate the differential effects of intravenous infusions of acetate, propionate, DL-lactate, or glucose on lipogenic enzyme activity in bovine subcutaneous (SQ) and intramuscular (IM) adipose tissue. Thirty Angus-sired intact heifers (576 ± 48 kg) were allotted to treatments by BW and ultrasound intramuscular fat percentage and intravenously infused for 48 h with either 1) 0.9% NaCl (CON), 2) acetate (ACE), 3) propionate (PROP), 4) DL-lactate (LAC), or 5) glucose (GLU). Heifers were fed a finishing diet formulated for 12% CP and 2.88 Mcal/kg ME. Heifers were fed twice daily and average daily ad libitum DMI was determined on d -5 to d -1. During infusion, CON heifers were fed at their previously determined ad libitum DMI levels. Heifers on the remaining treatments were fed at levels that provided 90% of daily ME from feed, while the remaining 10% of ME was provided by the appropriate infusion media. All heifers were infused at a rate of 150 ml/hr. Blood samples were collected prior to initiation of infusion and before each feeding. Immediately following exsanguination, SQ and IM adipose tissue were removed from the longissimus dorsi for determination of lipogenic enzyme activity. Heifers infused with GLU exhibited higher levels (P<0.05) of NADP-malate dehydrogenase (MDH) in IM compared to LAC (nmoles/minute/g adipose tissue). Activities of glucose-6-phosphate dehydrogenase (G6P), 6-phosphogluconate dehydrogenase (6PG), and acetyl-CoA carboxylase (ACC) in IM were not different (P>0.10) between treatments. Similarly, activities of MDH,

G6P, 6PG and ACC in SQ adipose tissue did not differ (P>0.10) between infusion treatments. During infusions, plasma glucose concentrations were numerically higher in GLU than CON, however, the difference was not significant (P>0.10). In summary, levels of acetate, propionate, lactate and glucose infused in this study were ineffective for enhancing IM or SQ lipogenic enzyme activity in market-ready cattle consuming a high concentrate finishing diet.

Key Words: Bovine, Adipose Tissue, Enzyme Activity

156 Effects of energy supply on methionine utilization by growing steers. G. F. Schroeder*, E. C. Titgemeyer, M. S. Awawdeh, and D. P. Gnad, *Kansas State University, Manhattan.*

We evaluated the effect of energy supply on methionine (Met) utilization in growing steers. Six ruminally cannulated Holstein steers (228 kg BW) were used in a 6 x 6 Latin square, housed in metabolism crates, and fed 2.8 kg DM/d of a diet based on soybean hulls (83%), wheat straw (7.6%), and cane molasses (4.1%). Treatments were abomasal infusion of two amounts of Met (0 or 3 g/d) and supplementation with three levels of energy (0, 1.3, and 2.6 Mcal ME/d) in a 2 x 3 factorial. The 1.3 Mcal/d treatment was supplied through ruminal infusion of 90 g/d acetate, 90 g/d propionate, and 30 g/d butyrate as well as abomasal infusion of 30 g/d glucose and 30 g/d fat. The 2.6 Mcal/d treatment supplied twice these amounts. Periods were 6 d with 2 d for adaptation and 4 d for sample collections. All steers received basal infusions of 400 g/d of acetate into the rumen and a mixture (125 g/d) of all essential amino acid except Met into the abomasum. No interactions between Met and energy level were observed. Nitrogen balance was increased (P<0.05) by Met supplementation from 23.6 to 27.8 g/d indicating that Met limited protein deposition. Nitrogen retention increased linearly (P<0.05) with energy from 23.6 to 27.6 g/d. Increased energy supply also linearly reduced (P<0.05) urinary N excretion from 44.6 to 39.7 g/d and plasma urea concentrations from 2.8 to 1.5 mM. Total tract OM and NDF digestibilities were reduced linearly (P<0.05) by energy supplementation from 78.2 and 78.7% to 74.3 and 74.5%, respectively. Whole body phenylalanine flux was not affected by treatment. Energy supply linearly increased (P<0.05) serum IGF-I from 694 to 818 ng/mL and quadratically increased serum insulin level (0.38, 0.47, and 0.42 ng/mL for 0, 1.3, and 2.6 Mcal/d, respectively). In growing steers, N retention was improved by energy supplementation even when Met limited protein deposition, suggesting that energy supply affects the efficiency of amino acid utilization. (Supported by NRI Competitive Grants Program/CSREES/USDA, Award No. 2003-35206-12837).

Key Words: Methionine, Energy Supply, N Retention

157 Evaluation of soybean hulls and protein sources of varying degradability on steer performance in feedlot receiving diets. C. J. Mueller*, R. H. Pritchard, and D. L. Boggs, *South Dakota State University, Brookings.*

A 52 d feedlot receiving study was used to evaluate the use of soybean hulls (SBH) in conjunction with protein sources of various degradability on gain performance and health status. Diets based upon oat silage (40%) were formulated for 11.75% CP. The control diet contained rolled corn and soybean meal (CO), while the test diets substituted SBH for corn and were supplemented with either soybean meal (SBM), dried corn gluten feed (DCGF) or dried distillers grains plus solubles (DDGS). All diets were predicted to have a negative degradable intake protein (DIP) balance. Performance was evaluated using 200 Angus steers (BW = 268 ± 2 kg) in a randomized complete block design utilizing orthogonal contrasts for treatment comparisons. Steers were blocked by previous origin and processed within 24 h of arrival. Steers within block were stratified by BW and randomly assigned to pen (8 to 11 steers). Pens (n = 5) were then assigned to dietary treatment. Intake was greater (P < 0.05) for SBM compared to CO during the initial 28 d (6.67 vs 6.29 kg) and overall (8.01 vs 7.58 kg), while ADG (1.53 ± 0.02 kg) and gain efficiency (195 ± 4 g gain/kg feed) were similar between the two treatments (P > 0.10). No differences were detected for intake, ADG or gain efficiency between SBM and corn co-products (DCGF and DDGS; P > 0.10). Steers fed the DDGS had greater ADG compared to DCGF during the initial 28 d (1.87 vs 1.69 kg; P < 0.05), but were not different after 52 d (1.52 vs 1.58 kg; P > 0.10). Intake and gain efficiency were similar between DDGS and DCGF during the initial 28 d and overall (P > 0.10). Morbidity and mortality were similar among treatments (11.1% and 0.5%, respectively; P > 0.10). This study indicates that

soybean hulls are a viable replacement for rolled corn in 40% roughage feedlot receiving diets. The use of corn co-products as a protein source with soybean hulls does not seem to limit performance, even though DIP balance varies among sources.

Key Words: Feedlot Steers, Receiving Diets, Co-Products

158 Effect of dietary crude and degradable protein concentration on feedlot performance, estimated nutrient excretion, and carcass characteristics. T. J. Biggs^{*1}, M. S. Brown^{1,2}, L. W. Greene^{2,1}, E. M. Cochran¹, E. A. Lauterbach¹, and J. R. Cortese¹, ¹West Texas A&M University, Canyon, ²Texas Agricultural Experiment Station, Amarillo.

Continued efforts are needed to refine dietary N needs to optimize feedlot cattle performance and promote environmental sustainability. Yearling steers (n = 315) were used to evaluate the effects of dietary CP and degradable protein on feedlot performance, nutrient excretion, and carcass characteristics. After adaptation to a 90% concentrate diet over 28 d, steers (375.5 ± 15.6 kg of BW) were fed one of three CP concentrations (11.5, 13, or 14.5% of DM) provided by one of three proportions of supplemental degraded intake protein (50, 75 or 100% of CP) in a 3 X 3 factorial (5 pens/treatment, 7 steers/pen) for 135 d. Urea and cottonseed meal were used in ratios of 100:0, 50:50, and 0:100, N basis. Diet CP and protein degradability did not interact (P > 0.15) for performance or carcass data. Steer ADG increased (P < 0.01) with diet CP (1.91, 2.03, and 2.23 ± 0.07 kg/d for 11.5, 13.0, and 14.5%, respectively), and gain:feed was improved as both diet CP and degradable protein increased (P < 0.07) from d 29 to 56 (immediately after reimplant). However, ADG tended (P = 0.14) to decrease as diet CP increased from d 85 to 112, and gain:feed increased as dietary CP decreased and as degradable protein increased (P < 0.09) from d 85 to 112. Thus, overall ADG, DMI, and gain:feed did not differ. Daily N and P retention, estimated by NRC equations, was not influenced (P > 0.10); steers retained 30.2 ± 0.5 g of N and 7.4 ± 0.1 g of P/d. Daily N excretion was not altered by degradability, but N excretion increased (P < 0.01) with dietary CP (143, 169, and 193 ± 5 g/d). Daily P excretion increased as CP increased and as degradability decreased (P < 0.01); P excretion ranged from 18 to 30 g/d. The number of low Choice or greater carcasses was reduced (Chi-square, P < 0.10) as dietary CP increased (64.1, 54.3, and 54.3), but other carcass attributes did not differ. Performance by yearling steers was not improved by a formulated CP above 11.5% or by altering the proportion of degradable protein, whereas carcass quality was enhanced by lower CP.

Key Words: Protein, Feedlot Performance, Nutrient Excretion

159 Oscillating protein concentrations of finishing beef cattle diets improves nitrogen retention by improving nitrogen digestibility. S. L. Archibeque^{*1}, H. C. Freely¹, N. A. Cole², and C. L. Ferrell¹, ¹USDA-ARS; U.S. Meat Animal Research Center, Clay Center, NE, ²USDA-ARS; Conservation and Production Research Laboratory, Bushland, TX.

We hypothesized that oscillating dietary CP concentrations would improve N efficiency and thus decrease overall N requirements and minimize contribution of nutrients to environmental systems. Eight Charolais-cross steers (358 kg BW) were used in a replicated 4x4 Latin Square design. The steers were allowed ad libitum access to the following finishing diets: 1) Low (Lo; 9.1% CP), 2) Med (11.8% CP), 3) High (Hi; 13.9% CP), or 4) Lo and Hi diets oscillated on a 48 h interval (Osc). Dry matter intake did not differ between treatments (P > 0.05), but N intake varied (P < 0.01) from 94 (Lo) to 131 (Med), 142 (Hi), and 133 g/d (Osc). Dry matter digestibility increased (P < 0.01) from 71.8 (Lo) to 75.8 (Med), 77.7 (Hi), and 77.5 % (Osc). Nitrogen digestibility increased (P < 0.01) from 62.2% (Lo) to 67.2 (Med), to 70.9 (Osc) and 70.1 (Hi). Nitrogen retention was greater (P < 0.01) in the steers fed the Osc diet (55.0 g/d) than either the steers fed the Lo (34.8 g/d) or Hi (40.2 g/d) diets. However, N retention of steers fed the Med diet (49.8 g/d) differed (P < 0.02) only from the steers fed the Lo diet. Urinary urea N was not different (P > 0.10) between steers fed either the Med (19.5 g/d) or Osc (21.3 g/d) diet. Similarly, urinary urea as a percentage of total urinary N did not differ (P > 0.10) between steers fed the Med (48.4) and Osc (51.5%) diets. Daily heat production tended (P < 0.09) to be less for the steers fed the Lo (177) diet than those fed the Med (189), Hi (188), or Osc (182 kcal/BW^{0.75}) diets. These data indicate that oscillating dietary protein will improve the N retention of finishing steers

compared to those in both excessive and deficient N states, while steers fed a similar daily concentration of dietary N in a static form only improved N retention compared to steers deficient in dietary N. Digestive mechanisms may play a greater role in this improvement in N retention than endogenous handling of nonprotein N.

Key Words: Heat Production, Oscillation, Metabolism

160 Prediction of ammonia release coupled to ammonia consumption. E. Venable^{*}, K. Ladyman, and M. Kerley, University of Missouri, Columbia.

Five dual-cannulated (rumen and duodenum) cross-bred beef steers were used in a 5x5 Latin square design experiment. The hypothesis of the experiment was that ammonia uptake by ruminal microbes could be estimated and that the estimated ammonia uptake could be coupled with ammonia release in the rumen. Diets were developed to fluctuate ammonia concentration in the rumen by using the degradation rates of rumen degradable protein (RDP). The objective of this experiment was to determine if the release rate of ammonia within the rumen could be managed to maintain an optimum level of ammonia concentration (2 mM) over a 12-hour period. Diet formulations were as follows: diet 1) 87% corn; diet 2) 85.5% corn, 1.25% SBM, 0.2% urea; diet 3) 84.1% corn, 2.5% SBM, 0.4% urea; diet 4) 82.7% corn, 3.75% SBM, 0.6% urea and diet 5) 81.3% corn, 5% SBM, 0.8% urea. All treatments contained 10% cottonseed hulls, 0.5% lime, 1.5% fat, and 1% vitamin and mineral mix. Diets 1 and 2 should be limiting in ammonia (< 2 mM) and diets 4 and 5 should have excess ammonia (> 2 mM). Diet 3 was expected to maintain an optimum ammonia concentration (2 mM). Samples were taken and analyses performed for volatile fatty acids (VFA), and ammonia. Additional samples were taken to measure both liquid and solid passage rate, total urinary nitrogen (N), and ruminal pH. Data were analyzed using PROC GLM of SAS. Total VFA production was greatest for diet 3 (P < 0.05). Acetate to propionate ratio was lowest for diet 5 (P < 0.05). Ammonia production increased with increasing levels of SBM and urea in the diet (P < 0.05). Ammonia concentration was optimized (2 mM) for diet 3 (P < 0.05) with diets 1 and 2 having lower (P < 0.05) and diets 4 and 5 having greater (P < 0.05) ammonia concentrations. These data illustrate that it is possible to use predictive equations relating protein degradability characteristics to ammonia release and consumption in the rumen. The potential to synchronize ammonia release to uptake in the rumen, thus lowering excessive ammonia production without reducing fermentative efficacy, would reduce N content of waste.

Key Words: Ammonia, RDP

161 Evaluation of RUP amino acid levels on lean tissue growth and carcass composition of beef steers fed a roughage-free diet. A. L. Mueller^{*}, W. H. Kolath, J. W. Golden, and M. S. Kerley, University of Missouri, Columbia.

Feeding RDP above what is needed for optimal microbial growth and efficiency results in inefficient use of CP for lean tissue growth. Previous research conducted in our laboratory demonstrated the potential of using RUP to optimize feed efficiency. Results from feeding levels of RUP above required predictions have not been studied. Therefore, we hypothesized that feeding a diet balanced in absorbable AA composition needed for lean tissue growth would maximize energy use for growth and that additional AA availability would not improve gain or efficiency. The objective of this study was to determine the optimum RUP AA level to maximize lean tissue growth of beef steers. Four diets contained increasing amounts of RUP and were fed to crossbred Angus steers in randomized complete block design. Treatment diets contained 70 % whole shelled corn and a pelleted supplement consisting primarily of blood meal (BM) and ground corn. The diets contained 6 (6BM), 9 (9BM), 12 (12BM), and 15 (15BM) % BM. The treatments were formulated to be isocaloric and contained different levels of CP and RUP AA. There were no differences in ADG (P > 0.05) among RUP treatments. The feed to gain ratio was highest for the 9BM and the lowest for the 6BM and 12BM treatments (P < 0.05). There were no difference in back fat and rib eye area among treatments (P > 0.05). Calves fed a roughage-free diet, but not optimized for AA flow had poorer feed conversion (P < 0.05). Using the NRC (2000), individual intakes and body weights were modeled for each diet. The lack of treatment effect on growth parameters in the presence of increased RUP AA was caused by energy limiting growth in all treatments and AA being supplied at

or above requirements. Using actual intakes the Mcal of NEg required for the observed gains were calculated to be within the NRC normal limits for lean tissue accretion. The 6BM treatment had similar gains and increases in carcass composition and a lower feed to gain than the

other treatments indicating it balanced the AA and energy for lean tissue growth. Supplying an AA profile that is balanced for growth relative to available energy, maximizes lean tissue growth and minimizes excess CP.

Ruminant Nutrition: Dairy - Minerals

162 Impact of minerals in water on ruminant production. J. G. Linn* and M. L. Raeth-Knight, *University of Minnesota, St. Paul.*

Water is an essential nutrient for all animals. In the consumption of water to meet this requirement, animals often consume significant amounts of various minerals. The effects of the minerals contained in water on animal performance or health are not well researched or documented with the exception of sulfates, salinity and nitrates. Most studies or reports relating water quality to animal performance and even EPA water guidelines have only considered the total mineral content of the water and not the chemical form and the availability of minerals from the water. It is well documented in the animal sciences literature that the chemical form of a mineral used in feed supplementation affects the availability of the mineral supplemented. In water, pH along with the chemical form of the mineral, affect the potential availability of the mineral from water. Magnesium for example is found as Mg^{+2} in most natural waters. When water pH is greater than 10, magnesium is usually combined with hydroxide to form MgOH. In water containing 1000 mg/L or more sulfate, significant amounts of Mg are combined with sulfate to form $MgSO_4$, whereas in waters low in sulfate, Mg complexes with bicarbonate or other anions. Routine water analysis only list total concentrations of minerals such as calcium, magnesium, chloride, sodium, sulfate, copper, iron, manganese and zinc along with pH. The chemical form or the availability of the mineral from water is not described. The objective of this presentation is to review what is known about the chemical forms of common minerals in water, the relationship between water pH and chemical form, the availability of minerals from water and ultimately relate this to requirements and potential affects on animal performance.

Key Words: Water Quality, Ruminant, Minerals

163 Quality water for dairy operations. K. Mancl*, *Ohio State University, Columbus.*

Water quality is determined from the beneficial use of the water. In dairy operations water is used both for cleaning equipment and drinking water for the animals. Each use has its own requirements. To ensure that water meets quality requirements, regular water testing is necessary. A good water test is not a waste of money. Annual water tests present a record of the water system that is critical to every dairy operation. If the water supply is damaged through human activity, evidence of a safe, adequate water supply is required to present an effective legal case.

If regular testing reveals a water quality problem, dairy operators have 4 options to solve it. 1. Improve water supply protection. 2. Find and eliminate sources of contamination. 3. Develop a new source of water. 4. Treat water to remove contaminants.

Key Words: Water Treatment, Water Testing

164 Effects of inorganic and organic (4-Plex^R) trace mineral supplementation on milk production and reproduction. J. D. Ferguson*¹, D. Tomlinson², and M. Socha², ¹*University of Pennsylvania, Kennett Square*, ²*Zinpro Corporation, Eden Prairie, MN.*

A total of 138 pregnant Holstein cows were blocked by parity, production and season of calving and randomly assigned within block to one of two dietary treatments: daily supplementation with 443 mg of Zn, 444 mg of Mn, 261 mg Cu, and 25 mg of Co as inorganic sulfates (control) or a combination of inorganic salts and complexed trace minerals (treatment, 14 g of 4-Plex/day; containing 360 mg Zn from zinc methionine,

200 mg Mn from manganese methionine, 125 mg Cu from copper lysine, and 25 mg Co from cobalt glucoheptonate). Diets were fed from -60 d from projected calving date through 250 d postcalving. Liver biopsy and claw examination were performed at -60 d, 30 d, and 250 d relative to calving. Serum was collected at 30 d postcalving for analysis of NEFA, cholesterol, betahydroxy butyrate, and total protein. Milk production was measured twice daily. Insemination and health events were recorded as they occurred. Milk composition for fat, protein, SNF, MUN and SMSCC was analyzed weekly from composite of consecutive a.m. and p.m. samples. Milk production and composition were analyzed with a repeated measures model, covariately adjusted for EPA and previous milk production, where appropriate, using the PROC MIXED procedure in SAS statistical software. Reproduction was analyzed using PROC LIFEREG. Milk production, milk fat and MUN were not significantly different between supplement groups. Milk protein was significantly different between supplement groups (control, 2.91 sem .01; treatment 2.95 sem .02, $p < .04$). First service conception rate was not different between the supplement groups (33% overall), however pregnancy occurred more rapidly in the treatment cows after first insemination (hazard .194 sem .119 $p < .10$). There was no effect of treatment on any health variables or cows culled for health problems. To more closely exam reproductive effects of the organic trace mineral supplementation, a large trial across several farms would be valuable.

Key Words: Trace Minerals, Production, Reproduction

165 Effects of inorganic and organic (4-Plex^R) trace mineral supplementation on claw lesions. J. D. Ferguson*¹, D. Tomlinson², and M. Socha², ¹*University of Pennsylvania, Kennett Square*, ²*Zinpro Corporation, Eden Prairie, MN.*

A total of 138 pregnant Holstein cows were blocked by parity, production and season of calving and randomly assigned to one of two dietary treatments: daily supplementation with 443 mg of Zn, 444 mg of Mn, 261 mg Cu, and 25 mg of Co as inorganic sulfates (control) or a combination of inorganic salts and complexed trace minerals (treatment, 14 g of 4-Plex/day; containing 360 mg Zn from zinc methionine, 200 mg Mn from manganese methionine, 125 mg Cu from copper lysine, and 25 mg Co from cobalt glucoheptonate). Diets were fed from -60 d from projected calving date through 250 d postcalving. Cows were housed in a free stall barn with concrete alleys. Examination of claws and surrounding soft tissues was made by a trained clinician at -60 d, 30 d, and 250 d relative to calving. Cows were confined into a restraining stall for examination. Feet were washed and hoof detritus removed with a knife blade. Lesions were classified according to Toussaint (R.E. Toussaint, 1989) based on macroscopic examination of hoof and tissues. All feet were examined by one trained veterinarian throughout the study. Keratinous lesions were classified as follows: dorsal wall ridges, erosion of the heel bulb, abaxial wall lesions, double soling, white line separation, sole abscess, sole hemorrhage, sole ulceration or sole erosion. Lesions of the surrounding soft tissue were classified as follows: digital dermatitis, pododermatitis of the digit or interdigital area, interdigital fibroma, or hairy heel wart. Lesions were mapped for location on the claw and surrounding soft tissues and graded as to severity (.5, 1, 1.5, 2, 2.5, 3, .5 being mild and 3 being the most severe). A repeated measures, multinomial model was used to examine hoof lesions using PROC GENMOD in SAS statistical software. A total of 3160 claw examinations were made. Heel erosions were the most frequent claw lesion across all treatments and time periods. Supplementation with organic trace minerals was associated with a reduction in solar lesions at 30 d postcalving. By 250 d postcalving lesions were not different.

Key Words: Trace Minerals, Hoof Quality, Dairy Cows

166 Effect of exogenous phytase on phosphorus digestibility in dairy cows and calves. D. Garikipati and R. Kincaid*, *Washington State University, Pullman.*

Two digestibility studies were conducted to determine if exogenous phytase improved phosphorus (P) digestibility in cattle fed diets containing barley. The first study evaluated exogenous dietary phytase on P digestibility in growing calves. Dietary treatments were: 0.37% P + no phytase; 0.37% P + 225 FTU/kg; 0.37% P + 450 FTU/kg; and 0.48% P + no phytase. Calves were fed the treatment diets from 6 to 12 wk of age. The diets contained an average of 0.86 mg phytate P/g of DM, i.e., about 23% of the dietary P was as phytate P. Growth rate (1.0 kg/d) and feed intake (1.2 kg/d) were not affected by dietary treatment. Plasma inorganic P (Pi) and the % P in the feces were increased ($P < 0.05$) by the high P diet but not by the exogenous phytase. Phosphorus digestibility, based upon lignin as an internal marker, was 81% in the calves and tended ($P = 0.1$) to be improved by exogenous phytase. The feces contained an average of 0.14 mg phytate P/g of DM and was not affected by exogenous phytase. In a second study, 16 lactating Holstein cows were arranged in 4 replicates of a Latin square with two grains (barley and corn), no or added exogenous phytase (427 FTU/kg TMR), and 4 periods of 21-d. Phytate P comprised about 50% of the total P (0.46%) in the TMR. Plasma Pi was higher ($P < 0.05$) in cows fed diets with exogenous phytase (5.7 vs 6.3 mg/dL). Using lignin as an internal marker, digestibility of phytate P (79.4% vs 85.3%) was increased ($P < 0.05$) by exogenous phytase. Although considerable phytase activity occurs in the rumen, physical properties of the diet and ruminal passage rates may prevent total hydrolysis of phytate. Whereas in young calves, exogenous phytase had little effect on P digestibility, exogenous phytase appears to increase absorption of P from dietary phytates in lactating cows.

Key Words: Phosphorus, Phytase, Cattle

167 Tissue selenium content and whole-blood glutathione peroxidase activity of lactating cows are increased by two organic forms of dietary selenium. M. R. Waldron*¹, T. L. Ward², M. T. Socha², and T. R. Overton¹, ¹*Cornell University, Ithaca, NY*, ²*Zinpro Corporation, Eden Prairie, MN.*

Forty lactating Holstein cows (90-170 DIM) were fed one of two organic forms of added dietary selenium (Se), an inorganic form, or placebo as a daily topdress to determine the effects of Se source on tissue selenium content and whole blood glutathione peroxidase (GPX) activity. All cows were fed a total mixed diet devoid of added Se. Following an initial 8-week depletion period, daily rations were topdressed with 7.5 mg of N-succinyl-L-selenomethionine (SSM; n=9), 7.5 mg of zinc-L-selenomethionine (ZSM; n=10), 7.5 mg of sodium selenite (NaSe; n=10), or 0 mg of added Se (CTL; n=10) in 25 g of sugar carrier. Treatments were continued for 8 wk and were then followed by a second four-week depletion period. Of the timepoints sampled, maximal tissue Se content occurred after 8 wk of supplementation; however, maximal whole blood GPX activity occurred 12 wk after the initiation of treatments, perhaps reflecting the time necessary for red blood cell turnover. Tissue Se content was increased by NaSe relative to CTL; however, both SSM and ZSM increased tissue Se content to a greater extent than NaSe. Whole blood GPX activity was increased by Se supplementation but was not different between NaSe, SSM, or ZSM. These results indicate that the SSM and ZSM forms of organic selenium have greater bioavailability and are thereby retained in tissues at higher concentrations than NaSe.

Tissue	CTL	NaSe	SSM	ZSM	SEM
Liver (ng/g dry wt)	660 ^a	1185 ^b	1709 ^c	1647 ^d	96
Plasma Se (ng/ml)	28.9 ^a	56.8 ^b	65.9 ^c	64.3 ^c	3.5
Whole blood Se (ng/ml)	92.6 ^a	119.1 ^b	137.1 ^c	139.6 ^c	5.6
Milk Se (ng/ml)	5.9 ^a	7.6 ^b	25.5 ^c	20.7 ^d	0.7
Whole blood GPX (EU/ml)	15.0 ^a	17.9 ^b	19.3 ^b	20.0 ^b	1.0

¹Largest standard error of the means;

^{abcd}Within row, means with uncommon superscripts differ ($P < 0.05$)

Key Words: Dairy Cow, Selenium, Bioavailability

168 Effects of molasses- versus corn-based supplements on the accumulation of selenium. J. D. Arthington* and F. M. Pate, *Range Cattle Research and Education Center, University of Florida, Ona.*

Results from previous studies indicate that the S component of molasses interferes with Cu accumulation into the liver of cattle. Selenium can also combine with S to form insoluble complexes. Therefore, the objective of this study was to investigate the accumulation of Se into the liver of growing steers provided molasses- or corn-based supplements. Twenty-four crossbred (Brahman x British) steers were stratified by BW and randomly assigned to individual pens (two steers/pen). Two supplemental treatments (6 pens/treatment) were formulated using corn and cottonseed meal or molasses and cottonseed meal. Each supplement was formulated to provide 1.5 kg of TDN and 0.3 kg of CP/hd. Supplemental Se (sodium selenite) was provided at a rate of 3.0 mg/hd daily. Supplements were fed 3 times weekly. To assess the effect of supplement composition on steer performance and Se status, individual steer weights, jugular blood, and liver biopsy samples were collected on d 0, 30, 60, and 90. Although intake of TDN did not differ among treatments, steers fed corn-based supplements tended ($P = 0.07$) to have a higher ADG compared to steers fed molasses-based supplements (0.10 and 0.24 kg/d for molasses- and corn-based supplements, respectively; SEM = 0.05). There was a significant ($P < 0.01$) sampling day x supplement source interaction for liver Se concentration. Steers fed molasses-based supplements had greater initial liver Se concentrations than steers fed corn-based supplements ($P = 0.02$). However, steers fed corn-based supplements had a greater overall increase in liver Se accumulation resulting in greater ($P < 0.01$) final liver Se concentrations vs molasses supplemented steers on d 90 (1.47 and 0.50 ppm; SEM = 0.18). There was no sampling day x supplement source interaction for plasma Se concentration or plasma glutathione peroxidase enzyme activity. These data suggest that components within molasses, namely S, inhibit the accumulation of Se into the liver of growing beef cattle.

Key Words: Selenium, Molasses, Corn

169 Manganese for lactating and dry dairy cows. W. P. Weiss*¹ and M. T. Socha², ¹*Ohio State University, Wooster*, ²*Zinpro Corporation, Eden Prairie, MN.*

The Mn requirement for lactating and dry dairy cows are 50 to 70% lower in NRC (2001) compared with the 1989 version. A Mn balance study (Exp. 1) was conducted using 18 dry Holstein cows to determine the intake of Mn needed to prevent body loss of Mn. These data were combined with a large data set (143 observations) in which Mn balance was measured using lactating (average milk yield = 30 kg/d) dairy cows (Exp. 2). In Exp. 1, dry Holstein cows were fed a standard diet (47 ppm Mn) starting at dry-off (approximately 60 d before parturition) and either given no supplemental Mn, or a daily bolus that provided 200 mg of Mn in the form of Mn sulfate or Mn methionine (Zinpro Corp., Eden Prairie MN). After approximately 30 d of receiving the treatments cows were moved to metabolism stalls for total collection of feces and urine for 4 d. Dry matter intake was not affected by treatment (11.8 kg/d). Intake of Mn for cows on the control, Mn sulfate, and Mn-met treatments were 471, 707, and 646 mg/d (control < supplemented; $P < 0.01$). Apparent digestibility of Mn (-2.6, 4.7, and 5.2% for control, Mn sulfate and Mn-met) was not different between supplemented groups but was higher ($P < 0.02$) for the supplemented groups than for the control group. Urinary excretion of Mn was not affected by treatment and was extremely low (< 0.5 mg/d). Apparent retention of Mn (-9.5, 20.2, and 24.5 mg/d for control, Mn sulfate, and Mn-met) was not affected by the form of supplemental Mn but was increased ($P < 0.06$) by Mn supplementation. When intake of Mn was regressed on Mn retention, tissue retention was 0 when the diet contained approximately 50 ppm Mn (approximately twice as high as the NRC requirement for dry cows). In Exp 2. Mn balance data measured in lactating dairy cows were regressed using Mixed Models procedures with trial included as a random variable to determine the average intake of Mn required to obtain 0 tissue retention. The resulting equation was: Mn balance (mg/d) = -190 + 0.29*Mn Intake (mg/d). Based on that equation an intake of 655 mg of Mn/d was required for 0 retention. That value corresponds to an average dietary concentration of 31 ppm of Mn which is approximately twice as high as the NRC recommendation for lactating cows.

Key Words: Manganese, Mineral, Requirement

170 Effect of glutamine supplementation on immune responsiveness and milk production in dairy cattle. L. Doepel¹, N. Gagnon¹, M. Lessard¹, G. E. Lobley², J. F. Bernier³, and H. Lapierre¹, ¹AAC Dairy and Swine R & D Center, Lennoxville, QC, Canada, ²Rowett Research Institute, Aberdeen, UK, ³Université Laval, QC, Canada.

Sixteen multiparous Holstein cows were used to determine the effect of glutamine (Gln) on immune responsiveness and milk production during the immediate postpartum period, when there are competing demands from the gut, mammary gland, and immune system. Cows received abomasal infusions of either 300 g/d Gln delivered in 10 L of water (8 cows) or water alone (8 cows) for 21 d following calving. During d14-21, treatments did not affect milk yield (39.3 vs. 40.5 kg, P = 0.66), protein content (2.99 vs. 2.98%, P = 0.87) or fat content (3.92 vs. 3.73%, P = 0.46), for water and Gln, respectively. Peripheral blood mononuclear cells (PBMC) were isolated from blood collected by jugular venipuncture on d -25, 4, 11, and 18 relative to calving. Interferon- γ concentrations, the lymphocyte proliferative response to concanavalin A (0.5 μ g/ml), and cell subpopulations were determined on the PBMC. Leukocyte counts and differential analysis were also performed on these days plus on d -12, -3 and 1 relative to calving. Interferon- γ concentration did not change over time (P=0.35). Lymphocyte proliferation was not affected by treatment (0.84 vs. 0.71 for water and Gln, respectively; P = 0.38), or by time (P = 0.44). There was a tendency (P=0.09) for a treat*time interaction for the CD4 population, due to a reduction at

d4 for the water treatment compared to d 11 and 18, while there was no change for Gln treatment. Leukocyte and neutrophil counts changed over time (P < 0.001), with the counts being higher on d1 than during the treatment period. The data from this study suggest that Gln supplementation does not improve the immune status of postpartum dairy cows.

	Pretreat ¹				Treat ²			
	Precalf	SEM	Day 1	SEM	Water	Gln	SEM	P ³
IFN- γ , pg/ml	1353.0	303.7	—	—	1042.4	1164.94	179.9	0.65
Cell count/ μ l								
Leukocytes	6642.3	368.9	9749.6	549.7	7203.2	7229.8	498.4	0.90
Eosinophils	458.8	—	227.0	—	251.0	195.8	—	0.59
Lymphocytes	2434.0	174.4	2536.0	243.5	2958.7	2717.6	220.7	0.58
Monocytes	686.7	58.9	1018.9	116.8	888.7	809.6	105.0	0.07
Neutrophils	2932.1	176.4	5830.7	520.5	3059.5	3276.8	528.1	0.75
Cytometry, %								
B cells	14.2	5.0	—	—	16.2	13.8	2.1	0.43
CD2	57.1	3.9	—	—	63.5	66.7	2.6	0.43
CD4	28.0	3.1	—	—	33.7	38.1	1.5	0.06
CD8	15.2	2.1	—	—	16.0	17.5	1.1	0.38
Gamma-delta	9.7	1.3	—	—	12.2	7.9	1.4	0.06

¹Pretreat=mean of d -25, -12, and -3, and both treatments;

²Treat=mean of d 4, 11, and 18; ³P=P-value for treatment effect

Key Words: Glutamine, Immune Response, Dairy

Breeding and Genetics: Genetics of Efficient Feed Utilization

171 Mechanisms regulating feed intake: role of appetite-regulating peptides. M. G. Thomas* and K. L. Shirley, *New Mexico State University, Las Cruces.*

Feed intake, or appetite, is a multifaceted physiological event. Regulation of feed intake can be attributed to, or modulated by, energy expenditure, the interaction of diet with the digestive system, and (or) central mechanisms influenced by flux of neurotransmitters and neuropeptides. The latter directs discussion towards the basal hypothalamus as a focal point by which the brain receives input of the body's metabolic state and interprets this information for appetite and modulation of other systems such as growth, reproduction, or lactation. Discovery and research of gut and appetite-regulating peptides has been increasing for almost a century. In the last decade, considerable emphasis has been placed on hormones derived from adipose tissue, such as leptin and adiponectin. Leptin is a physiologic antagonist to a potent orexigenic brain peptide, neuropeptide Y (NPY). The leptin receptor is co-localized with NPY on neurons within the ventro-medial hypothalamus of the ruminant. Intracerebroventricular (ICV) infusion of NPY stimulates appetite and infusion of leptin suppresses appetite. Suppression of appetite has also been observed with central infusion of insulin. These types of studies were effective for evaluating neuro-regulation of appetite; however, they may only explain gross effects of these neuropeptides on appetite, as concomitant to ICV infusion studies, increases in serum concentrations of leptin parallel increases in daily feed intake level and body weight in growing animals. Thus, fine control of appetite may be more related to gene regulation or receptor binding affinity for factors such as NPY and leptin. For example, as ruminants age and fatten, leptin receptor expression levels appear dynamic within the hypothalamus and pituitary. Development of marker assisted selection programs are challenging, especially for polygenic traits such as level of feed intake or residual feed intake. Further understanding of the influences of environmental and intrinsic factors are needed to narrow this search for candidate genes. Physiologic knowledge of signals of adiposity, neuropeptides, and their receptors could aid this process.

Key Words: Appetite, Neuropeptide Y, Leptin

172 Genetic variation in feed utilization: selection responses in mice. M. K. Nielsen*, *University of Nebraska, Lincoln.*

Selection for high (MH) or low (ML) heat loss per unit size (kcal/kg^{0.75}/d), measured in direct calorimeters, and no selection (MC), have been practiced in mouse lines as a proxy measure for feed energy requirement for maintenance. Selection was only in males. All selection lines were present in 3 independent replications making a total of 9 lines.

Selection ceased after 16 generations. All 9 lines were maintained without intentional selection for 26 generations. Selection recently resumed and is practiced again for the same criterion (high or low or no selection) in each of the lines. During the original selection, realized heritability of heat loss was 0.28. After initial selection, feed intake was 9% greater in MH and 11% less in ML, both as compared to MC. After re-initiating selection, feed intake is 7% greater in MH and 15% less in ML, both as compared to MC. Differences in heat loss and feed intake persist through very mature ages. No difference in longevity has been detected. Genetic correlations with heat loss, and probably maintenance energy requirement, are: positive with ovulation rate and locomotor activity, negative with body fatness. Locomotor activity of MH mice was twice that of ML, and MC mice were intermediate. Locomotor activity differences explained 36% of the differences in maintenance feed intake between lines. When reared in hot or cold environments, there was no line x environment interaction for feed intake, body weight or fatness. MH mice had reduced litter size in the cold, but performance of ML mice relative to MC did not interact with environment. ML mice are adaptable to chronic stressors, but MH mice are not, as measured by serum corticosterone level. Estimates of energy costs per unit of gain (total, or fat and non-fat) do not appear to be different between the lines. Thus, genetic variation in feed intake, after accounting for possible differences in rate and composition of gain, appear to be mostly if not totally explained by differences in maintenance energy costs per unit size. Selection to reduce energy for maintenance was successful; non-desirable responses were a reduction in ovulation rate and an increase in body fatness.

Key Words: Selection, Feed Intake, Mice

173 Genetic evaluation of efficient feed utilization in beef cattle. D. H. Crews, Jr.*, *Agriculture and Agri-Food Canada Research Centre, Lethbridge, Alberta, Canada.*

The wide range of traits for which most beef breed associations predict EPD focus on increasing the outputs of the production system, thereby increasing the genetic potential of cattle for reproductive rates, weights, growth rates, and end product yield. Feed costs represent a large proportion of the variable cost of beef production and genetic improvement programs for reducing input costs will likely include traits related to feed utilization. Feed conversion ratio, defined as feed inputs per unit output, is a traditional measure of efficiency that has significant phenotypic and genetic correlation with feed intake, growth rate, and mature size. One limitation is that favorable decreases in feed to gain as correlated response to increased growth rate does not necessarily relate to specific improvement in efficiency. Residual feed intake is defined as the difference between actual feed intake and that predicted on the basis of requirements for maintenance of body weight and production. Phenotypic

independence of residual feed intake with growth rate, body weight, and other energy depots can be forced, however, genetic associations may remain when phenotypic regression is used. Heritability estimates for phenotypic residual feed intake have been moderate, ranging from 0.26 to 0.43. Genetic correlations of phenotypic residual feed intake with feed intake have been highly positive, suggesting that improvement would produce the correlated response of decreasing feed intake. Residual feed intake estimated by genetic regression results in zero genetic correlation with its predictors thus alleviating concerns over long term antagonistic response in increased mature size and maintenance requirements. The genetic regression approach requires knowledge of genetic covariances of feed intake with growth rate and weight. Cost of individual feed intake measurement on potential replacements will be a consideration for implementation of national cattle evaluations for efficiency of feed utilization. These costs must be compared to expected and, if possible, realized rates of genetic progress and associated reductions in feed input requirements.

Key Words: Genetic Evaluation, Beef Cattle, Feed Efficiency

174 Realities of measuring feed intake on individual pigs to genetically improve feed efficiency. D. S. Casey*¹ and P. W. Knap², ¹*Pig Improvement Company, Franklin, KY*, ²*Pig Improvement Company, Germany*.

Feed efficiency is an important economic trait to the swine industry. Most improvement has been made indirectly by selecting on lean growth rate, but can also be improved by selecting for growth when feed intake is restricted. Neither of these methods involves measuring feed intake on the pig, but if done would result in a direct measurement of feed efficiency. The objective of this review was to discuss issues involved in measuring feed intake on individual pigs. Feed intake can be obtained by penning pigs individually, but pigs in this situation tend to eat more, grow faster, and are fatter than pigs housed in groups. To avoid this genotype x housing system interaction, electronic feeders were developed to measure individual feed intake on group-housed pigs. These feeders are single-spaced and offer some protection from competition, whereas conventional feeders offer no protection. These feeder differences did not affect performance of boars, but gilts on electronic feeders ate less, grew slower, and deposited less backfat and loin muscle area. Data from electronic feeders have also been found to contain substantial amounts of errors that require editing. Different editing methods have been shown to affect the accuracy of feed intake estimates, which in turn affect heritability estimates. Operating these feeders takes time and requires highly trained personnel. They are also costly, which usually limits the number of pigs that can be evaluated. Testing strategies can be adapted to increase the number of pigs measured during a test period with minimal impact on accurately estimating feed intake. This

Combined Animal, Dairy, and Poultry Extension Workshop

176 Development of model biosecurity programs. J. Shutske*, *University of Minnesota, St. Paul*.

Bio- and agricultural security programs designed to protect animal health and minimize risk often contain components such as facility access control, personal hygiene, sanitation, and animal quarantine/isolation protocols. Biosecurity protocols are often implemented using checklists that guide the user in the process of evaluating current practices and environmental/equipment conditions. These checklists provide a basis for continuous improvement. We have learned in other areas of risk control that the most effective measures to reduce risk/loss involve efforts to eliminate potential hazards through equipment and system-level design rather than heavy reliance on human action and behaviors which can be highly variable and subject to competing motivations. This becomes increasingly important as animal agriculture becomes more reliant on a labor force that may include individuals with limited knowledge of animal production, animal health, or even a basic understanding of personal health behaviors and practices. Workers themselves may, in fact, be the most crucial link within a successful production security program. Being on the front lines of an operation, workers are in the best position to monitor environmental conditions, observe changes in animal health, suggest improvements, and provide an ongoing evaluation of an operation's biosecurity program. Other industries have recognized and embraced the role of the workforce in implementing quality control and improvement. Workers are also the ones who will have the first expo-

sure to hazardous biological and chemical agents that could impact an operation. Thus, an effective biosecurity program should also have some means of monitoring and protecting worker health. Based on the few events in the U.S. where there have been intentional breaches of security within the food system, it is also clear that those in the labor force could also be involved in facilitating (or preventing) an event whether intentionally or otherwise. So, biosecurity programs, educational materials, and checklists created in the future should encourage producers to engineer out potential hazards and should holistically consider the role of workers in implementing and providing continuous evaluation of biosecurity programs.

Key Words: Swine, Feed Efficiency, Feed Intake

175 Methods of editing errors in data from electronic swine feeders impact heritability estimates of average daily feed intake. D. S. Casey* and L. Wang, *Pig Improvement Company, Franklin, KY*.

Methods of editing errors in data from electronic swine feeders affect accuracy of estimating average daily feed intake (ADFI), which will impact genetic improvement of feed efficiency. The objective of this study was to measure the effect of two editing methods on heritability estimates of ADFI. FIRE[®] electronic feeders were used to measure feed intake for 7,106 boars from approximately 73 to 163 d of age. Feed intake data were edited using two methods (EM1, EM2). For EM1, errors were identified in daily feed intake (DFI), occupation time per day, and mean DFI for a pen. Corresponding DFI records were replaced with a missing value. Data for a pig were discarded if the percentage of missing DFI was >75. DFI records were regressed on test day for each pig using a 4th order polynomial. Estimates of DFI from this model were used to calculate ADFI. Unreasonable values for ADFI from individuals and off-test groups were discarded. For EM2, 16 criteria were used to identify errors in visits. A linear model was used to adjust error-free DFI for the effect of errors. Unreasonable values of DFI were replaced with a missing value. Data for a pig were discarded if the percentage of missing DFI was >85. Adjusted DFI were regressed on test day for pigs in an off-test group using a random regression model that included a 3rd order polynomial for the fixed curve for each line (n=10) and a 1st order polynomial for the random curve for each pig. Missing values of DFI were replaced with estimates from this model. A sire model was fit to ADFI from the two editing methods. The model included on-test weight x line, herd-line-year-season, and herd-off-test group. After editing there were 6,197 (87.2%) and 6,861 (96.6%) pigs with an estimate of ADFI from EM1 and EM2. Mean ADFI for EM2 was 51 g/d larger and the standard deviation was 29 g/d smaller. Heritability estimates were .18 and .27 for EM1 and EM2 and the phenotypic correlation was .88. Methods of editing errors in data from electronic swine feeders impact estimates of heritability thus affecting genetic improvement of feed efficiency.

Key Words: Feed Intake, Editing Methods, Heritability

177 Catastrophic Composting: Is it safe and effective? J. M. DeRouchey*, J. P. Harner, and J. P. Murphy, *Kansas State University, Manhattan*.

Key Words: Biosecurity, Engineering, Labor

Composting of animal mortalities has increased in popularity in recent years due to decreased availability and increased costs associated with the traditional animal rendering industry. However, with increasing foreign animal disease and transmission concerns, composting has received considerable more attention as a potential method for mass mortality disposal. Limited research has shown composting can reduce pathogens

and parasites up to 99.99% when heated to 55°C for 3 consecutive days, such as *E. coli* and *Salmonellae*. Also, composting has been shown to effectively eliminate the highly pathogenic avian influenza virus after 10 d of composting and tissues from chickens infected with egg drop syndrome-76 virus after 20 d. However, little other data is available on effectiveness on other animal diseases. A number of challenges are present that operators must overcome properly compost large masses of diseased mortality animals. First, in areas of large animal density, there may be a lack of adequate carbon sources (straw, hay, silage, sawdust, etc.) to adequately cover and compost mortalities. Composting sites need proper drainage and collection areas, security from predators and setback distances to not jeopardize public health if the disease is transferable. Water addition for maintaining the compost with adequate moisture (50-60%) is imperative. For large carcasses turning the piles may be necessary to thoroughly degrade tissue and bones. However, this may expose transmittable pathogens to the air during turning if they had not been properly heated for the desired treatment time. All activities with composting will require human activity, which may have direct health concerns if the disease is highly contagious and proper handling procedures are not followed. Composting mass mortalities may be effective in certain instances. However, numerous challenges will prevent its widespread use in catastrophic mortality events.

Key Words: Composting, Mortality, Livestock

178 What are extension's roles in the early detection of agro-terrorism events? R. M. Smith*, *USDA, CSREES, Washington, DC.*

The early detection of an agro-terrorism event is essential to help contain the damage and to decrease any adverse economic impact. Across the United States extension will be expected to play an important role in early detection through the development and implementation of training and educational programs. The dissemination of accurate and timely information by extension agents to people working within the agricultural sector will enhance our nation's ability to rapidly and accurately detect an intentional agro-terrorism event. Extension personnel will be integrated into the National Animal and Plant Diagnostic Laboratory Network system as it matures. Their involvement with these networks will help to ensure a more rapid submission of suspected plant and animal samples to these state and university diagnostic laboratories. This presentation will review a few of the current or proposed national initiatives to support the role of extension personnel in the early detection of agro-terrorism events.

Key Words: Extension, Diagnostics, Agro-terrorism

179 Use of antibiotics and alternatives in the animal industries: What is extension's role? R. B. Phillips*, *Animal Health Institute, Washington, DC.*

The use of antibiotics to keep food animals healthy is a continuing source of controversy despite several lines of evidence that producers and the public benefit from the practice and that these benefits outweigh the very small risk of antibiotic resistance transfer via the food chain. Recent reductions in the use of antibiotics can be attributed to several factors, including the observation of judicious use principles and increased management. Confinement and increased biosecurity, while derived by some as factory farming, has several benefits including disease prevention. The search for other alternatives to antibiotics is limited by research funding and a lack of flexibility in the regulatory approval process. Extension can assist producers in evaluating the benefits of antibiotics, the alternatives, and by helping them implement judicious use principles.

Key Words: Antibiotics, Judicious Use

180 Country of origin labeling: update and path forward. J. D. Lawrence*, *Iowa State University, Ames.*

Country of Origin Labeling was part of the 2002 Farm Bill and was scheduled to become mandatory September 30, 2004. The House and Senate voted to delay it for 2 years. While debate rages over how it should be implemented by both opponents and proponents, producers, markets, and processors remain confused about what to do and where to start. Parallel to COOL is movement toward a national animal identification system. National ID is not COOL, but it will make COOL

more practical to implement. Extension has a significant role in helping producers understand what is required under both programs, how they differ, and the motivation behind them.

Key Words: COOL, National ID, USAIP

181 Opportunities for extension professionals in international education. J. P. Blake*, *Auburn University, Auburn, AL.*

There are numerous opportunities for international colleagues bound by a common thread to share in the exchange of information. Numerous organizations support agricultural based projects overseas, with a major source of funding originating from U.S. Agency for International Development (USAID) via the US Farm Bill. Partner organizations that share in this funding through the Farmer-to-Farmer program include: ACIDI/VOCA (Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance), Citizen's Network for Foreign Affairs, Land O'Lakes, Inc., Partners of the Americas, and Winrock International. These programs rely on the expertise of volunteers from U.S. farms, land grant universities, cooperatives, private agribusiness' and nonprofit farm organizations to provide assistance to individual farm enterprises, cooperatives, farmer's associations, agribusiness', rural credit institutions, universities, and agricultural youth groups overseas. Commodity groups such as the American Soybean Association (ASA) and U.S. Grains Council (USGC) also recruit experts that are involved with technical programs that teach livestock and poultry producers how to use feed grains effectively and manage operations efficiently. The Fulbright Scholar Program administered by the Council for International Exchange of Scholars (CIES) offers opportunities for international educational exchange. Fulbright grants are awarded to U.S. citizens and nationals of other countries for a variety of educational activities which may include, university lecturing, advanced research, graduate study, and teaching in elementary and secondary schools. The primary mission of extension is to "take the university to the people". Whether the scope is local, regional, national, or international, the essence of extension supports key projects, which may include the building of partnerships, improvement of business practices, increasing productivity and profitability, and introducing new technologies. In addition, opportunities for scientific exchange contribute to an increased understanding of history, culture, politics, and social structure.

Key Words: International, Extension, Fulbright

182 Cultural issues in processing plants and on farms. W. V. Jamison*, *Dordt College, Sioux Center, IA.*

Latino immigration is prominent in the US poultry industry and carries with it profound cultural manifestations. It is a result of increasing globalization which is defined as the flow of labor and capital across market concentration gradients, e.g. either the money goes to where the poor are or the poor come to where the money is. Anecdotal evidence and LIUNA estimates indicate that over 50% of workers in many plants and 10% of farm labor are now Latino. Immigration will continue to define human resource management in the poultry industry, and the proposed blanket amnesty and worker permit program will exacerbate immigration trends. Also, the influx of Latinos will provide a ready labor supply that both artificially suppresses wages and antagonizes native residents. While Huntington argues that Latinos are poorly assimilated and increasingly strident in rebuffing enculturation in favor of aggressive Latino identity, Brooks argues that assimilation can and will occur as American culture adapts to and compromises with Latino immigrants. However, both views are incomplete. More accurately, Bohon argues that assimilation will be episodic and dependent on ethnicity, regional social factors, and the existence of successful Americanized kinship networks. These findings imply that immigrant labor is successfully suppressing wages while subtly reshaping American culture. In processing plants, cultural, ethnic and religious conflicts between Anglos and Latinos, as well as Latinos and other racial and ethnic groups, will continue to intensify. In poultry processing regions increasing immigration will strain social and economic infrastructures, and the development of a permanent ethnic underclass entrenched in barrios is indicated. Finally, on-farm day labor will pose an increasing biosecurity risk as a

largely invisible labor force transits from farm to farm unrestricted by biosecurity protocol.

Key Words: Latino, Immigration, Assimilation

183 Extension's role in conflict resolution and consumer education. M. M. Schutz* and J. S. Ayres, *Purdue University, West Lafayette, IN.*

The role of extension dairy, poultry, and livestock educators is evolving rapidly; and to be relevant, we must continue to provide science-based information to an ever-broadening clientele. Campus-based specialists have remained insulated from this shifting paradigm longer than field-based staff that often facilitate disputes involving agriculture. Examples of conflicts involving animal agriculture include disagreements over manure or odor regulations, animal welfare, animal cloning, and food safety (for example sales of raw milk). The situational framework of Heifetz and Sinder describes three situations that illustrate the shifting paradigm faced by extension specialists. In the first situation, both a problem and a solution are clear, which characterizes the traditional role

of extension specialists as experts in a particular field. The second situation, where a problem is clear but a solution is not; is familiar ground for those of us trained as scientists. But the third situation, where both the problem and solution are unclear, will become more common as we tackle the larger societal issues facing animal agriculture. In 1988, Carpenter and Kennedy put forth the concept of a spiral of unmanaged conflict. Initially, the problem arises, sides form, and positions harden. But as the conflict spirals out of control, communication stops, resources are committed, conflict spills outside the community, perceptions become distorted, and a sense of crisis emerges. As livestock, dairy, or poultry extension specialists, our best opportunity is to be involved and to provide science-based solutions or alternatives before the conflict begins to spiral out of control. Once communication stops, even science-based information may be misinterpreted as advocacy. Unfortunately, in most cases we are not properly trained and do not feel comfortable in dispute resolution; and our reward systems within our universities do not properly recognize efforts in public issues education, conflict resolution, or consumer education.

Key Words: Extension, Conflict Resolution, Consumer Education

Dairy Foods: Perspectives on Raw Milk Cheeses

184 Survival of *Escherichia coli* in Cheddar and Colby cheese. D. R. Henning*, *South Dakota State University, Brookings.*

Trials evaluating survival of *Escherichia coli* in Cheddar cheese provided data indicating this organism will survive 60 days of curing if present in sufficient numbers and cheese composition is favorable for the organisms survival. Cheddar cheese manufacturing and curing were used for two treatments utilizing a cocktail of three strains of *E. coli* O157:H7. The target for treatment one was 10^3 colony forming units per mL (cfu/mL) in pasteurized cheese milk; treatment two was 1 cfu/mL of cheese milk. Cheeses were analyzed at 0, 14, 28, 42, 60, and 74 d, and at 28 d intervals thereafter until *E. coli* O157:H7 could no longer be detected in two successive sampling periods. When no cfu/g were detected by plating, 25 g of cheese were enriched to detect viable *E. coli* O157:H7. Treatment one resulted a two log reduction in cfu/g after 60 days of curing with viable *E. coli* O157:H7 being detected in 25 g of cheese after 150 days. Treatment two resulted in reduction of *E. coli* O157:H7 numbers to 1 or <1 cfu/g in 60 days with none detected in 25 g of cheese at 150 days. Both treatments permitted the survival of *E. coli* O157:H7 for more than 60 days of curing. The second study mathematically described the decline of viable biotype 1 *E. coli* during the curing of cheese. Pasteurized milk was inoculated with 10^2 to 10^9 cfu/ml for making Cheddar and Colby cheeses. Multiple regression was employed to determine the effects of low to high levels of composition and curing temperatures in typical cheese [moisture (34 to 40%), pH (5.0 to 5.6), curing temperature (4 to 13C), and salt level (0.8 to 1.7%)] on survival of *E. coli* during cheese curing. A total of 56 survivor curves representing combinations of the parameters were generated during four-months of curing. The model for surviving biotype 1 *E. coli* can be described as: $\text{Log}(\text{Days}4\text{D}) = -74.64881 + 28.5745^*P - 0.00098^*M^*T + 2.64579^*P^*P$, where Days4D = time, in days, needed to reach 99.99% inactivation, P = pH, M = moisture, and T = temperature. $R^2 = 0.532$.

Key Words: Cheese Curing, *Escherichia coli* Survival, Survival Model

185 Use of heat-treated cheesemilk to make high quality Cheddar cheese. B. Luth*, *Tillamook County Creamery Assn., Tillamook, OR.*

The primary argument in favor of creating cheese from heat-treated milk is to retain the quality and flavor characteristics of the cheese as it ages. This process is used because natural enzymes in the milk, essential for producing quality cheddar cheese, suffer during full pasteurization. One of the distinguishing attributes of Tillamook Cheddar Cheese is the consistent ability to age cheddar cheese for two years or more without the development of bitter or atypical flavors. Studies have been conducted using commercial vats of cheesemilk that have been pasteurized compared to commercial vats of cheesemilk heat-treated at 150° F. These were sampled over time for blind analysis by trained panels. Results show that pasteurized cheese only five months old was determined to be significantly different in flavor and texture when compared to heat-treated control samples made at the same time. The panels noted flavor

attributes of bitter, bland and flat and the texture deficiency of pasty body for the pasteurized product. The process of pasteurization of milk at 161° F for 15 seconds was designed and implemented for the control of pathogenic and spoilage microorganisms. Studies have demonstrated, however, that many organisms are inactivated by heat treatments of 148° F or above for 16.2 seconds and that heat-treatment of cheesemilk is but one of the technologies and practices which contribute to the manufacture of safe cheese. It is recommended that the heat-treatment process be recognized for cheesemaking based on the following parameters: 1. Raw Milk intended for heat-treatment meets the following requirements on a daily average: SPC < 15,000 cfu/ml; SCC < 250,000 cells/ml, indicating that the milk was from healthy animals. 2. Raw milk is heated to 148° F or greater and held for a minimum of 16 seconds. 3. Finished cheese produced under these conditions will be cured at a temperature of greater than 35° F for a period of at least 60 days.

Key Words: Cheese, Heat-Treatment, 60 Day Hold

186 Approaches to ensuring the safety of raw milk cheeses. C. Donnelly*, *The University of Vermont, Burlington.*

Although cheeses have been linked with documented outbreaks of foodborne illness, epidemiological evidence collected from around the world confirms that this occurs infrequently. Cheeses can become contaminated with bacterial pathogens as a result of their presence in raw milk used for cheesemaking and subsequent survival during the cheesemaking process. Alternatively, bacterial pathogens can contaminate cheese via post-processing contamination if sanitation and other measures in the processing plant are not sufficient to prevent re-contamination. The characteristics of the specific cheese variety will dictate potential for growth and survival of microbial pathogens, with ripened soft cheeses presenting a higher risk for growth and survival of pathogens in comparison with aged hard cheeses where a combination of factors including pH, salt content and water activity interact to render cheeses microbiologically safe. This presentation will compare and contrast approaches used worldwide to insure the safety of raw milk cheeses. The 1996 European Union Statutory Instruments contain regulations for hygienic production and marketing of milk and milk based products. EU regulations establish limits for pathogens in raw milk cheese, where presence of *S. aureus* and *E. coli* would indicate poor hygiene. The relative merits of such approaches in the context of assuring cheese safety will be reviewed.

Key Words: Cheese, Safety, Pasteurization

187 Survival of a five strain cocktail of *Escherichia coli* O157:H7 during thermalization and the 60 day aging period of hard cheese made from unpasteurized milk. J. Schlessler*, *Food and Drug Administration, NCFST, Summit-Argo, IL.*

Cheeses have been cited as vehicles for outbreaks of foodborne illness. The standard of identity for hard cheeses requires pasteurization of the milk or as an alternative treatment, a minimum 60-day aging for cheeses

made from unpasteurized milk, to eliminate the foodborne pathogens. From 1948 to 1988, there were 6 confirmed foodborne disease outbreaks in the U.S. transmitted with domestically produced hard cheeses as the food vehicle. Various research reports have raised concerns about the public health protection provided by the current 60-day aging period in the manufacture of hard cheeses made with unpasteurized milk. The objective of this study was to investigate the adequacy of the 60-day minimum aging to eliminate the foodborne pathogens and evaluate milk thermalization as a process to improve the safety of hard cheeses made from unpasteurized milk. Hard cheese was made from unpasteurized milk inoculated with a five-strain cocktail of acid-tolerant *E. coli* O157:H7. 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. Populations of *E. coli* O157:H7 increased during the cheese making operations. Population of *E. coli* O157:H7 in cheese aged for 60 and 120 days at 7 °C, decreased less than 1 log and 2 logs, respectively. Experiments were conducted at 64.4 °C for 16 seconds on milk inoculated with *E. coli* O157:H7 at 10⁵ CFU/ml. Supply milk and thermalized milk were taken at 0, 45 and 90 minutes to determine the levels of *E. coli* O157:H7. Thermalization runs resulted in a 5-D *E. coli* O157:H7 reduction.

Key Words: Thermalization, *Escherichia coli* O157:H7, Raw Milk Cheese

188 An integrated approach to the safety of raw milk cheeses. P. S. Kindstedt*, *University of Vermont, Burlington.*

In the ongoing quest to reduce the risk of foodborne illness associated with cheese, the goal should be to achieve the appropriate level of

safety using approaches that are both effective and practical, and that avoid placing unnecessary burdens and restrictions on cheesemakers and cheese consumers. Among the possible approaches that could be implemented to enhance cheese safety, mandatory pasteurization of all milk for cheesemaking stands out as being exceptionally burdensome and restrictive to producers and consumers of raw milk cheeses. Expanding mandatory pasteurization to include all cheeses should not be pursued if the appropriate level of safety already exists under current regulations or can be achieved through other practical and effective but less burdensome and restrictive approaches. Recent research strongly suggests that some raw milk cheeses, such as the highly cooked hard Italian and Emmental-types, present very low microbiological risks when made and aged properly. A strong argument can be made that these raw milk cheeses achieve the appropriate level of safety as a consequence of the high heat treatment that they receive during manufacture, their chemical composition and their long ripening times. Therefore, the safety emphasis for these cheeses should be on insuring that cheesemakers are adequately trained in cheese technology, hygiene and safety and held to appropriately high standards, rather than on mandatory pasteurization. For other raw milk cheeses that pose greater microbiological risks and which are deemed to fall short of the appropriate level of safety under current regulations, at least two different approaches should be evaluated and compared for overall merit: 1.) mandatory pasteurization; 2.) a combination of other safety approaches such as mandatory technical and safety training for cheesemakers (e.g. via a cheesemakers certification or licensing requirement), mandatory implementation of an approved risk-reduction (e.g. HACCP-like) program, and mandatory finished product testing for pathogens. The latter approaches have been used for raw milk cheesemaking in some European countries with apparent success.

Key Words: Cheese, Safety, Pasteurization

Extension Education: Applied Reproductive Management Symposium: Beef and Dairy Cattle Topics

189 Using melengestrol acetate (MGA)-based protocols to synchronize estrus prior to fixed-time artificial insemination in postpartum beef cows. D. J. Patterson*, F. N. Kojima, and M. F. Smith, *University of Missouri, Columbia.*

Beef producers are often restricted in their operations from implementing production-enhancing technologies, including estrus synchronization and AI, due to a lack of time and labor. The inability to predict time of estrus for individual cows in a herd often makes AI impractical to use because of the labor required for detection of estrus. The development of methods to inseminate beef cows at a fixed time with high fertility should result in a dramatic increase in the adoption of AI in beef herds. Although hormonal treatment of cows to group estrous periods has been a commercial reality for over 30 yr, producers have been slow to adopt this management practice. Perhaps this is because of past failures, which resulted when females that were placed on estrus synchronization treatments failed to resume normal estrous cycles following calving, and the reality that early estrus synchronization protocols failed to synchronize follicular waves, resulting in more days in

the synchronized period. These factors collectively precluded the application of fixed-time AI with acceptable pregnancy rates. We proposed the general hypothesis that progestin treatment prior to the GnRH-PG estrus synchronization protocol would successfully: 1) induce ovulation in anestrus postpartum beef cows; 2) reduce the incidence of a short luteal phase among anestrus cows induced to ovulate; 3) increase estrous response, synchronized conception and pregnancy rates; and 4) increase the likelihood of successful fixed-time AI. This review considers recently developed methods to control estrous cycles of postpartum beef cows with MGA. New methods of synchronizing estrus in beef cows with the MGA Select or 7-11 Synch protocols prior to fixed-time AI present the opportunity to enhance results from AI and eliminate the need to detect estrus entirely. These new protocols provide an opportunity for the beef cattle industry to expand the application of this important reproductive technology by making the implementation of an AI program feasible.

Key Words: Beef Cow, Estrus Synchronization, Progestin

PSA Air Emissions & Poultry Production

190 Air emissions in poultry production: Current challenges and future directions. R. Angel¹, W. Powers², and T. J. Applegate³, ¹*University of Maryland, College Park*, ²*Iowa State University, Ames*, ³*Purdue University, West Lafayette, IN.*

In the last few years, regulatory focus has been on nutrient management from animal feeding operations (AFOs) with recent emphasis on air emissions. Concerns are with air-borne emissions of nitrogenous compounds as well as with small particulate matter (PM 2.5). Of specific interest to the Environmental Protection Agency and specific states include ammonia, hydrogen sulfide, nitrogen oxides, sulfur oxides, nitrous oxide, and volatile organic compounds but the main challenges are establishing current emission levels and determining best methodologies for measuring these accurately. Currently methodologies to measure air emissions under field and research conditions exist and are being further developed but extensive challenges exist as to both accuracy and

precision of the different analytical methods. Current best estimates are based on a mass balance modeling approach (Air Emissions From Animal Feeding Operations, NRC 2003) but due to lack of current biologically generated data to use in the models, nutrient excretion and emission levels appear to be overestimated by these models. Extensive work is being done on dietary strategies to reduce nitrogenous excretions from poultry but the impact of these on air emissions is not always defined. Litter management strategies that reduce volatilization of nitrogenous and other compounds have shown promise and are being further developed. Flock, house, and whole farm management strategies are also being successfully implemented and further developed. The magnitude of the potential impact on air emissions of each of these strategies is still in question. There is no question, though, as to the need for the use of whole farm systems that implement different strategies at all

management levels if large decreases in air emissions from AFOs are to be achieved.

Key Words: Air Emissions, Poultry, Mass Balance

191 Air emissions from layer houses. A. J. Heber*, T. Lim, and J. Ni, *Purdue University, West Lafayette, IN.*

Measurements of air emissions from confined animal buildings are perhaps more challenging for laying hens than any other species. Modern laying houses typically have the greatest volume, the greatest mean live mass density, the greatest number of exhaust fans, the highest ridge, the largest particles, and the highest concentrations of ammonia and particulate matter (PM). This paper describes a comprehensive air emission measurement program carried out for over six months at a 250,000-hen high-rise caged-hen building. Continuous measurements of gas and particulate matter (PM₁₀, PM_{2.5}) concentrations, building static pressure and airflow, inside and outside temperature and humidity, wind speed and direction, and barometric pressure were conducted. Extractive air sampling was used to provide continuous gas streams to two sets of gas analyzers and to fill sample bags for odor evaluations. Ammonia (NH₃), hydrogen sulfide (H₂S), carbon dioxide (CO₂), and odor were measured using chemiluminescence, pulsed fluorescence, photoacoustic infrared detectors, and olfactometry, respectively. PM was measured in the exhaust air using three tapered element oscillating microbalances. Ventilation rates were assessed by monitoring fan operation and static pressure, and testing fans with a portable fan tester, and a certified fan testing lab. During 6 days in June, the average daily mean ($\pm 95\%$ c.i.) concentrations and emissions were 39 ± 8.0 , 518 ± 74 , and 1887 ± 563 $\mu\text{g}/\text{m}^3$ and 1.1 ± 0.3 , 16 ± 3.4 , and 63 ± 15 g/d-AU for PM_{2.5}, PM₁₀, and total suspended particulates (TSP), respectively. PM emission was correlated to ventilation, ambient and exhaust temperatures, and relative humidity ($P < 0.05$). Ventilation inlet and exhaust odor concentrations ranged from 43 to 74 and 216 to 451 European odor units (OU_E) per m³, and averaged 51 and 316 OU_E/m³, respectively. Mean H₂S concentrations of ventilation inlet and exhaust air were 3.1 and 19.7 ppb, respectively. Mean H₂S emission rate was 5.6 $\mu\text{g}/\text{s-AU}$. The overall mean odor emission rate was 65.6 OU_E /s-AU. Odor emissions were correlated to ventilation rate, and building temperatures. The average NH₃ emission rate was about 200 g per day per 500 kg live mass.

Key Words: Ammonia, Particulate Matter, Odor

192 Ammonia emissions from broiler houses. A.J. Pescatore*, K.D. Casey, and R.S. Gates, *University of Kentucky, Lexington.*

Ammonia levels in poultry houses are a concern due to the impact on bird performance including poor feed efficiency, blindness and respiratory problems. Recently, there has been increased interest in ammonia as it relates to emissions. EPA through its safe harbor program and third party lawsuits under CERCLA and EPCRA regulations has increased the concern of the poultry industry. Ammonia emissions are a function of the level of ammonia in the exhaust air and the ventilation rate. Accurate measurements of both ammonia concentration and rate of ventilation is essential for determining ammonia emissions. A study was conducted over five consecutive flocks to determine ammonia emissions from four commercial broiler houses with built up litter. Ammonia levels in exhaust air were determined by using Portable Measuring Units (PMU) equipped with two Drager PAC III electrochemical gas monitors. A Fans Assessment Numeration System (FANS) was used to determine exhaust fan capacity. Placement densities were either 10.75 or 13.44 birds per square meter depending on final body weight. The results of this study indicated that there is seasonal variation in the pattern of ammonia levels in the exhaust air from broiler houses. The fall and winter flocks had increasing ammonia levels in the exhaust air with increasing bird age. While the two summer flocks demonstrated a decreasing ammonia level with regard to bird age. The one spring flock was highly variable. Ammonia levels for the five flocks ranged from 1 to 40 ppm. During all five flocks, ammonia emissions which are a function of ammonia level and ventilation rate increased linearly with bird age. Average maximum ammonia emissions (g/bird/day) were .93, 1.01, 1.45, 1.73, and 1.27 for the five consecutive flocks. The lowest level for ammonia emissions occurred early in the flock and ranged from .01 to

.45 g/bird/day. Results from this study indicate that the rate of ventilation as opposed to ammonia level had a greater effect on ammonia emissions.

Key Words: Ammonia Emissions, Broiler, Ammonia Levels

193 Dietary strategies to lower nitrogen load in poultry. D. J. Burnham*, *Ajinomoto Heartland LLC, Chicago, IL.*

The poultry industry has made tremendous strides over the past 50 years to meet the demands of the retail and foodservice industries for increasing supplies of inexpensive and safe meat and eggs. The pressure to lower cost and increase supply has led to higher efficiencies which have only been possible through larger more integrated facilities. In certain areas these facilities with higher concentrations of livestock has resulted in some environmental concerns which include ammonia and odors. The poultry industry is now being challenged to reduce emissions by some of the same groups that have driven the industry into expansion and consolidation. The move toward mandating lower nitrogen emissions in the United States is inevitable. To meet these limits the poultry industry will need to either reduce the number of birds placed or implement feeding practices that minimize the feeding of excess nitrogen (crude protein). The first step in reducing ammonia emissions is to more accurately define the amino acid needs of a bird. With more accurate requirements we are able to design feeds with reduced levels of excess protein in the feed. The second step in reducing ammonia is to develop procedures that allow for more frequent feed changes. Current practices of changing broiler feeds every 14 to 20 days results initially in underfeeding followed by overfeeding of nutrients. Changing diets more frequently will reduce nitrogen emissions by improving efficiencies and reduced feeding of excess nutrients.

Tools available to nutritionist in their pursuit of reduced nitrogen emissions include commercially available crystalline amino acids. Making full use of them to more accurately balance feeds can significantly reduce excess crude protein. Unfortunately, there is still a common belief that lowering of the crude protein level of feeds negatively affects performance. The research presented in this paper strives to demonstrate to the poultry industry in the US that by embracing these technologies we can move toward lower crude protein, more efficient feed formulation and achieve the same level of performance with lower nitrogen emission at a lower cost of meat and eggs

Key Words: Nitrogen, Low Protein, Amino Acids

194 Management strategies to reduce air emissions: emphasis ammonia. P. H. Patterson*, *Department of Poultry Science, The Pennsylvania State University, University Park.*

Air emissions generated by poultry production are numerous and can include odors, dust, endotoxins, and nitrogenous compounds. Ammonia (NH₃) emissions have the potential to contaminate surface waters, while, nitric oxide and nitrous oxide lead to the formation of nitric acid, a principle component of acid rain. These emissions in and around poultry production facilities can be a health and performance issue for birds and their caretakers, and an environmental concern on both a local and global scale. Dietary strategies can aid in the reduction of many airborne emissions including NH₃. Management techniques to quell, capture or eliminate these air contaminants are numerous but vary in their cost, effectiveness and practicality. Many strategies that control dust also control the release of odorous compounds, microorganisms and NH₃ that can adhere to dust particles. Techniques for dust control include cleaning and vacuuming, fogging with water and oil, ionization, electrostatic filtration, air scrubbing techniques, and vegetative shelterbelts. Impermeable covers for manure reduce emission rates by reducing radiation and wind velocity. Biofilters trap and treat exhaust air from mechanical ventilation systems combining filtration (woodchips, or straw) with biological conversion in compost to capture emissions. Litter and manure amendments include those that inhibit microbial growth and conversion of nitrogenous compounds to NH₃; clays that absorb moisture, odors and NH₃; and acidifying agents such as ferrous sulfate, ferric chloride, and aluminum sulfate that convert NH₃ to NH₄⁺. Rapid drying techniques for litter and manure can significantly reduce NH₃ volatilization. These include slotted floor systems for turkeys, ventilated floors for broilers and new cage systems for layers each reducing litter and

manure moisture and NH₃ losses compared to conventional systems. Although many strategies are available to address NH₃ and other air emissions, ultimately regulations and costs will be determining factors guiding implementation.

Key Words: Ammonia, Air Emissions, Management

195 Emissions, regulations and impact in the EU and The Netherlands. H. Ellen*, *Applied Research of Animal Sciences Group of Wageningen, Lelystad, The Netherlands.*

Air pollution has been one of Europe's main political concerns since the late 1970's. The aim of EU-policy is to develop and implement appropriate instruments to improve air quality. The Sixth Environment Action Programme, "Environment 2010: Our future, Our Choice" regards the period from 2001 until 2010. One of the important issues of the EAP is the reduction of greenhouse gasses. This also supports the aims of the Kyoto-Protocol, because EU-countries have promised to decline their emissions with 8% in total in 2010 in comparison with 1990. In the EAP each country of the EU has an Emission Ceiling for gasses as SO₂, NO_x and NH₃. According to an EU-directive these emission

ceilings have to be reached in 2010. In addition to the EU-rules, each country have to implement its own national programme for a progressive reduction of the national emissions. For poultry, the reduction of NH₃-emission is the most important issue in the EAP. Already there was EU-directive in 1996 concerning the integrated pollution prevention and control (IPPC). According to this directive no new poultry farm larger than 40,000 bird places may be operated without a permit. From 2007 all farms need a permission and have to use a so called BAT. These are techniques that aim to reduce emission of ammonia at acceptable costs. Large farms have to make a Environmental Impact Assessment when they apply for a new permit. For already many years in Holland poultry farms require a permit in which also the amount of ammonia and odour emission is registered. Lists of ammonia and odour emission factors for all the housing systems in the different poultry categories has been established. To fulfil the EU-directive 2001/81/EC, the Dutch government has set maximum values for the ammonia emission from farms. Together with the environment regulations, poultry farmers also have to deal with EU-directives on animal welfare. Most of the housing systems that give good welfare, have higher emissions of ammonia. These systems also consume more energy, which doesn't harmonise with the need to reduce the emission of CO₂.

Key Words: Ammonia Emission, Environment, Poultry

Food Safety in Animal Production

196 A USDA multi-agency project: Collaboration in animal health, food safety & epidemiology (CAHFSE). R. R. Kraeling*¹, E. J. Bush², D. A Dargatz², N. E. Wineland², S. Ladely¹, and P. J. Fedorka-Cray¹, ¹ARS, USDA, Athens, ²APHIS-VS, USDA, Fort Collins, CO.

The emergence of antimicrobial resistant zoonotic bacteria continues to be a global concern. In response to growing surveillance needs, USDA-ARS, APHIS and FSIA collectively developed CAHFSE. CAHFSE will enhance our overall understanding of pathogens that pose a food-safety risk by tracking these organisms from farm to plant. Risk analysis, antimicrobial use information, resistance and animal health will also be assessed. The first commodity of CAHFSE is pork. Currently, blood and fecal samples are being collected quarterly on sentinel farms in four states. Herd health and management data are also being collected from these farms. To date, fecal samples from 48 site visits have been collected and cultured for Salmonella, Campylobacter and E. coli. Salmonella was recovered from 8.1% (146/1811) of the samples. Sixteen serotypes were identified, of which the predominant serotypes included; S. derby (31.5%), S. typhimurium var. copenhagen (26%), S. heidelberg (8.9%) and S. give (7.5%). Across all serotypes, resistance was most commonly observed for tetracycline (90.4%), streptomycin (63.5%), sulfamethoxazole (43.5%) and ampicillin (43.5%). Among generic E. coli, resistance to tetracycline (92.2%), sulfamethoxazole (27.2%), streptomycin (27.1%) and ampicillin (25.4%) was most common. All Campylobacter isolated to date were identified as C. coli. Resistance to tetracycline (73.6%), azithromycin (60.3%) and erythromycin (60.1%) were observed most often. Determination of risk factors related to prevalence and antimicrobial resistance of these organisms will lead to practical methods of mitigating food borne illness.

Key Words: Swine, Food Safety, Antimicrobial Susceptibility

197 Monitoring the safety of edible poultry tissues: Antibiotic residue concentrations can vary between different muscle tissues. I. Reyes-Herrera*¹, M. J. Schneider², K. Cole, P. J. Blore, and D. J. Donoghue, ¹Department of Poultry Science, University of Arkansas, Fayetteville, ²USDA/ARS/ERRC, Wyndmoor, PA.

The use of veterinary antibiotics is an important tool for the treatment of disease in poultry. However, misuse of these antibiotics can create antimicrobial residues in edible animal tissues exceeding the FDA established safety tolerances. To ensure the safety of the U.S. food supply, the Federal Government monitors foods, including poultry, for illegal residues. For the veterinary antibiotic enrofloxacin (Baytril®), the FDA, in the Code of Federal Regulations, has listed muscle as the tissue to be monitored in poultry, irrespective of the type of muscle tissue. This study was conducted to determine if either breast or thigh meat is a better indicator of the highest enrofloxacin concentrations. One

hundred and sixty five, 5-wk old chickens were dosed with the FDA approved dose of enrofloxacin in water. The 4 treatment groups were: 25 ppm for 3 days, 25 ppm for 7 days, 50 ppm for 3 days and 50 ppm for 7 days. Five chickens from each treatment group were randomly selected and samples of breast and thigh muscle tissue were collected prior to dosing (controls, n=5), during the dosing (n=5/group/day) and for a 3-day withdrawal period (n=5/group/day). Each sample was prepared and assayed using an agar diffusion microbiological method (Schneider and Donoghue, Poultry Science, 2004). The results demonstrated that greater overall concentrations of enrofloxacin were present in breast versus thigh muscle tissues during the dosing period (443 ± 22 ppb vs. 386 ± 24 ppb. P < 0.05). These data indicate that, at least for enrofloxacin, not all muscle tissues incorporate antibiotics at the same concentrations. Therefore, the Federal Government should consider monitoring specific muscle tissues to ensure established safety tolerances are not being exceeded.

Key Words: Enrofloxacin Residues, Muscle Tissues, Chicken

198 Survival of Salmonella species following sodium hypochlorite treatment during commercial broiler processing. R. M. Lipscomb*, L. T. Walker, W. L. Hurlock, L. L. Williams, and M. Verghese, *Alabama A&M University, Normal.*

Technological advances and mass production in poultry processing present new challenges for providing a microbiologically safe product. Research has shown that Salmonella can survive acidic conditions. The objective of this study was to determine the effect of Acidified Sodium Hypochlorite (ASH) on survival of Salmonella species on commercially produced broiler carcasses. Broiler carcasses were sampled from four processing steps (rehang, reprocessing, prechill, and postchill) to determine the effect of ASH against Salmonella. Ten carcasses were sampled at each processing step. Carcasses were dipped (20 secs) in an ASH solution dip tank at prechill and rinsed (1 min) with 400ml Butterfield's Phosphate Dilution water (BPD). A 1:10 dilution was plated onto Brilliant Green and Bismuth Sulfite agars, incubated for 24 hours at 37C, and Salmonella counts were determined. Salmonella O Poly A and H Poly A antigens were determined by serotyping. Salmonella species were confirmed by PCR analysis. The experiment was replicated three times over three periods. The results showed that average Salmonella counts were 1.2888 log cfu/ml (rehang), 0.9403 log cfu/ml (reprocessing), 0.9779 log cfu/ml (prechill), and 0.2039 log cfu/ml (postchill). Means for 48 and 72 hours were not significantly different at p#88050.05. Of a total of 53 suspect Salmonella isolates (including all reps), 37 were positive for the Salmonella O Poly A antigen, and 50 samples were positive for the Salmonella H Poly A antigen. PCR analysis confirmed 32 samples to be Salmonella species.

Although ASH was effective in reducing microbial contamination, *Salmonella* species survived ASH treatment. Several factors can influence the effectiveness of ASH such as pH, temperature, and ASH concentration. Regulation of pH, temperature, and ASH concentration is the key to ASH achieving its full potential as a disinfectant used in the poultry industry.

Key Words: Salmonella, Broilers, Sodium Hypochlorite

199 Herd-level factors associated with cow and calf *Salmonella* shedding in a multi-state study of 129 dairy farms. C. P. Fossler¹, S. J. Wells¹, J. B. Kaneene², P. L. Ruegg³, L. D. Warnick⁴, J. B. Bender¹, L. E. Eberly¹, S. M. Godden¹, and L. W. Halbert², ¹University of Minnesota, St. Paul, ²Michigan State University, East Lansing, ³University of Wisconsin, Madison, ⁴Cornell University, Ithaca, NY.

This study evaluated associations between herd characteristics and the isolation of *Salmonella* from dairy cows and calves. 129 conventional and organic farms in Minnesota, Wisconsin, Michigan, and New York were enrolled without regard to previous *Salmonella* history. Herds were sampled up to 5 times at 2-month intervals over one year. *Salmonella* was detected in fecal samples from 4.9% of 20,089 cows and 3.8% of 4,673 preweaned calves. Risk factors were evaluated using multivariable logistic regression with the generalized estimating equations approach, and within-herd prevalence by visit in cows and calves was the outcome used for cow and calf models, respectively. Factors associated with an increased odds for *Salmonella* shedding in the final cow model ($p < 0.05$) included lack of use of tiestall or stanchion facilities for lactating cows, not storing all purchased concentrate or protein feeds in an enclosed building, not using monensin in weaned calf or bred heifer diets, cow access to surface water, disposal of manure in liquid form (slurry or irrigation, as opposed to broadcast/solid spreader) on owned or rented land, and eating or grazing roughage by cows from fields having surface application of manure during the growing season. Factors associated with an increased odds for *Salmonella* shedding in the final calf model ($p < 0.05$) included lack of routine feeding of medicated milk replacer, and use of calving pen as a hospital area for sick cows > once a month. Herd size and farm type (organic vs. conventional) were not associated with *Salmonella* shedding in the final cow or calf models. A number of herd-level risk factors were identified in this study that could potentially be implemented in *Salmonella* control programs on dairy farms.

Key Words: *Salmonella*, Dairy Cattle, Risk Factors

200 Investigation of cattle feedlot management practices to reduce *Escherichia coli* O157. J. R. Ransom*, K. E. Belk, J. A. Scanga, J. N. Sofos, and G. C. Smith, Colorado State University, Fort Collins.

Studies have shown that prevalence of *Escherichia coli* O157 on/in cattle entering the packing plant range from 10 to >70%. The objective of this study was to determine the effectiveness of single and multiple preharvest pathogen intervention strategies on the prevalence of *E. coli* O157 on/in cattle before transport to harvest. Cattle from 24 pens [approximately 200 head of cattle (419 kg) per pen] were randomly allocated (3 pens/treatment) to one of 8 treatment groups: Control (CT; No treatment), Bovamine (Bov; a *Lactobacillus acidophilus* product), NEOMIX (Neo; neomycin sulfate), an *E. coli* O157:H7 bacterin vaccine (Vac) and all combinations of the single treatments. Treatments of Bov and Vac began 60 d preharvest, and Neo was administered for 3 d before harvest with a 24 h withdrawal period. Twenty-five cattle per pen were randomly sampled using rectal fecal collection and by sponge-swabbing 500 cm² of the dorsal-thorax region. Cattle were sampled within a 10 d timeperiod and samples were collected no more than 48 h before harvest. Results showed that CT cattle had the highest pathogen prevalence levels (45.8 and 40.3%, for fecal and hide samples, respectively), and cattle receiving treatments had a lower prevalence of *E. coli* O157 than did CT. Trends suggested that Neo was the most effective single intervention, reducing *E. coli* O157 prevalence levels to 0.0 and 8.5%, in feces and on hides, respectively. Bovamine and Vac used singly, were equally effective, as pathogen prevalence was reduced to 22.7 and 20.0%, respectively, on hide samples and to 13.3 and 14.7%, respectively, for fecal samples. When Bov, Vac and Neo were used in

combination, pathogen prevalence for fecal and hide samples were reduced to 2.7 and 6.7%, respectively. In general, combinations of interventions resulted in lower pathogen prevalence than when a single intervention was used. This study demonstrated that preharvest mitigation strategies used singly or in combination can be effective in reducing the prevalence of *E. coli* O157 in market-ready feedlot cattle.

Key Words: Cattle, Preharvest, *Escherichia coli* O157

201 Colicin E1, N and A treatment inhibits growth of *Escherichia coli* O157:H7 strains in vitro. T. R. Callaway¹, C. H. Stahl², T. S. Edrington¹, K. J. Genovese¹, L. M. Lincoln², R. C. Anderson¹, R. B. Harvey¹, and D. J. Nisbet¹, ¹USDA/ARS, Food and Feed Safety Research Unit, College Station, TX, ²Department of Animal Science, Iowa State University, Ames.

Escherichia coli O157:H7 is a highly virulent food-borne pathogen that causes severe human illnesses and inhabits the intestinal tract of ruminants. Although abattoir do an excellent job of controlling the cross-contamination of pathogens, too many human illnesses linked to animal-derived food products still occur. Therefore, researchers have investigated methods to reduce the overall burden of *E. coli* O157:H7 entering the abattoir within the live animal. Antibiotic treatment has been proposed to reduce *E. coli* O157:H7 populations in the live animal; however, with the growing worldwide concern over the prophylactic use of antibiotics in food animals, alternative strategies to the use of traditional antibiotics must be explored. Colicins are antimicrobial proteins produced by some *E. coli* strains that are inhibitory or bactericidal against other *E. coli*. In the present study, the efficacy of three pore-forming colicins E1, N and A were quantified in vitro against *E. coli* O157:H7 strains 86-24 and 933. All three colicins reduced the growth of *E. coli* O157:H7 strains, but the efficacy of each colicin varied between strains. Colicin E1 was most effective against strain 86-24 and 933. Colicin N, while less effective than E1, was very effective against strain 86-24, however, it was unable to produce more than a 50% reduction in growth against strain 933. Colicin A did not show more than 50% of the efficacy of either of the other colicins, even when added to incubations at 10-fold or greater protein concentrations. Colicin E1 was more effective against both strains of *E. coli* O157:H7 than colicins A and N, and reduced populations of *E. coli* O157:H7 more than 1000-fold at concentrations less than 5 µg/ml. Colicin N reduced populations of strain 86-24, but not 933; and colicin A did not affect the populations of either *E. coli* O157:H7 strain tested. These potent antimicrobial proteins may potentially provide an effective and environmentally sound pre-harvest strategy to reduce *E. coli* O157:H7 populations in ruminant animals.

Key Words: *E. coli* O157:H7, Intervention Strategy, Colicin

202 Effects of lactic acid treatments on microbiological, chemical, and sensory properties of stored fresh beef trimmings. S. E. Rose*, K. E. Belk, J. N. Sofos, J. A. Scanga, K. L. Hossner, and G. C. Smith, Colorado State University, Fort Collins.

The objective of this study was to evaluate the effectiveness of warm (55°C) lactic acid (LA) at various concentrations (1.25, 2.00, or 2.50%) on microbiological, chemical, and sensory properties of fresh beef trimmings stored at 4°C for 0, 2, 5, or 8 d on Styrofoam™ trays wrapped with air-permeable cellophane film. Two replicates of four beef short plate (BSP) pieces (5 cm x 2.5 cm x 1 cm; 40 cm²) per treatment were immersed in treatment solutions or water control at 55°C for 30 s. Aerobic plate counts (APC) were determined using Petrifilm™ Aerobic Count Plate (ACP), and Total Coliform Count (TCC) and *Escherichia coli* (ECC) populations were determined using Petrifilm™ *E. coli*/Coliform Plate (ECCP). Lactic acid concentrations of the BSP pieces were determined by conducting enzymatic colorimetric assays. A sensory panel was used to determine differences in odor of BSP pieces after treatment and during storage. A MiniScan XE was used at each storage time to evaluate color (L*, a*, and b* values) of muscle and adipose tissue. Bacterial populations associated with BSP pieces treated with 1.25% LA were not different ($P > 0.05$) from controls; however, 2.00 or 2.50% LA reduced ($P < 0.05$) APC, but did not ($P > 0.05$) reduce TCC, when compared to controls for all storage days. All ECC were below the detection limit in all treatments and the control at all storage days. Lactic acid concentrations associated with BSP pieces treated with 2.00 or 2.50% LA at all storage days were higher ($P <$

0.05) compared to control BSP pieces. There were no differences ($P > 0.05$) in odor between treatments and the control BSP pieces for all storage days. Lactic acid treated BSP pieces were more likely to be lighter, greener, and more yellow throughout the storage period when compared to control BSP pieces. Lower microbial counts and indistinguishable odor differences were achieved with 2.00% LA treated BSP pieces. Using 2.00% LA in beef trimmings may provide a microbiologically cleaner product to the consumer without major adverse effects on quality.

Key Words: Lactic Acid, Beef Trimming, Residue

203 Influence of aflatoxin B1 on milk production and health in dairy sheep. G. Battacone¹, M. Palomba², M. Pascale³, A. Mazzette¹, and G. Pulina^{*1}, ¹*Dipartimento di Scienze Zootecniche, University of Sassari, Italy via Enrico de Nicola 9, 07100 Sassari, Italy*, ²*Dipartimento Farmaco Chimico Tossicologico, University of Sassari, Italy via Muroni, 07100 Sassari, Italy*, ³*CNR Istituto di Scienze delle Produzioni Alimentari, Bari, Italy via le Einaudi 51, 70125 Bari, Italy*.

The transfer of aflatoxin B1 in the diet of lactating sheep into the milk were investigated, and also its effects on milk yield and animal health. Twenty lactating Sarda sheep were divided into four groups of five. Three groups were used for the experiment and the fourth was a control group. The experimental design was a 33 Latin square with one additional group. The experimental groups were given 32, 64 or 128 μg per

day of pure aflatoxin B1 (AFB1) in two daily doses, given immediately before milking at 7:00 a.m. and 7:00 p.m.. The treatment continued for 7 days, followed by a 5 day clearance period. The control group was fed an aflatoxin-free diet. Individual milk production was recorded and milk sampled at each milking. Blood samples were collected after 7 days. Aflatoxin M1 (AFM1) levels in milk were determined using an immunoaffinity column - HPLC method. AFM1 appeared in the milk of all treated groups 12 h after the beginning of administration. No AFM1 was found in the milk of the control group. AFM1 concentrations above the EC tolerance level (0.05 $\mu\text{g}/\text{kg}$) were detected even in the milk of the group that received only 32 $\mu\text{g}/\text{d}$ of AFB1. The mean AFM1 concentration in milk reached a steady state after 2-3 days. At this point AFM1 concentration did not differ at morning and evening milking. The AFM1 concentration was linearly related to the dose. No AFM1 was detected 3-4 days after the end of treatment with AFB1. This suggests that the Latin square is an appropriate experimental design for mycotoxicological studies. The milk production traits of the AFB1 groups were no different from those of the control group. These doses of AFB1 had no effect on hematological and biochemical blood parameters. The results indicate that the level of AFB1 used did not adversely affect animal health and milk production traits, while considerable amounts of AFM1 were excreted in the milk. (Partly supported by MIUR-MiPAF SISPROLAT project)

Key Words: Aflatoxin, Sheep, Milk

ADSA-ASAS Northeast Graduate Student Competition

204 Fractional removal of amino acids by the small intestines and whole gastrointestinal tract of sheep remains constant across levels of protein supply. S. W. El-Kadi*, N. E. Sunny, M. Oba, S. L. Owens, and B. J. Bequette, *University of Maryland, College Park*.

We hypothesized that the net removal of amino acids (AA) by the mesenteric (MDV; small intestine) and portal (PDV; whole gut) drained viscera of sheep would remain fixed in amount, even with increasing supply of protein to the gastrointestinal tract (GIT). Wethers ($n=4$, 33 ± 2.0 kg) were fitted with catheters for duodenal infusion of casein and for measurements of PDV and MDV appearance of AA. Animals were fed a forage-based diet low in protein (9.5 % CP) to 1.4 \times maintenance and given 5-d duodenal infusions of casein (0, 35, 70 and 105 g/d) in a 4 \times 4 Latin square design. On day 5 of each period, a blood flow marker was infused and blood continuously withdrawn over 1-h intervals during a 4-h period. Plasma concentrations of AA were determined by isotope dilution with mass spectrometry. Net absorption of AA across the PDV and MDV were calculated as the product of veno-arterial difference and blood flow. Regression analyses were performed to establish equations describing net appearance of AA in relation to AA infusion rate as casein. Regression curves were found to best fit a first-order model ($R^2 = 0.60-0.95$; at least $P < 0.05$) for all AA except Val ($R^2 = 0.50$; $P = 0.06$). The large removals of the branched chain AA (43-51%; $P < 0.05$) by the GIT probably relates to their catabolism for energy production. For Lys, however, it is unclear why the GIT net metabolizes (33%; $P < 0.05$) this potentially limiting AA to a much greater extent than for His, Phe and Met, whose fractional removals by the GIT were lower (7-19%). Our data indicate that AA removal by the GIT is not fixed in amounts, but rather that the amount removed increased with greater protein supply. The fates and factors affecting AA metabolism by the GIT have yet to be elucidated. However, if AA are metabolized by the GIT to provide energy then perhaps there may be opportunity to reduce catabolism by providing energetically equivalent non-AA substrates.

Key Words: Amino Acid, Sheep, Gastrointestinal Tract

205 Regulation of urea recycling to the gastrointestinal tract and ammonia metabolism in ruminants. N. E. Sunny*, L. H. Hanus, S. W. El-Kadi, S. L. Owens, and B. J. Bequette, *University of Maryland, College Park*.

Urea recycling is the main N salvage mechanism allowing ruminants to maintain positive N balance on poor quality diets. Our aim was to determine the extent ruminants control urea recycling to the GIT, independent of rumen microbial metabolism. Thus, four wether lambs (28.1 kg BW) were fed to 1.5 \times maintenance energy a pelleted diet containing

(kg^{-1} , as-fed) 1.7 Mcal ME and only 68 g CP. Animals were assigned to four levels of urea-N infusion (0, 3.8, 7.5, 11.3 g/d) arranged in a 4 \times 4 Latin square design. Urea was infused into a jugular vein for 10-d periods, and urea kinetics determined by continuous infusion of [¹⁵N¹⁵N]urea over the last 80 h. During [¹⁵N¹⁵N]urea infusion, total urea was collected by suction and feces by harness. Isotope enrichment of urinary urea (¹⁵N¹⁵N, ¹⁴N¹⁵N and ¹⁴N¹⁴N) and fecal total ¹⁵N was determined by mass spectrometry. Urea-N entry rate (UER) increased (5.1 to 21.8 g/d; $P < 0.0001$) with level of urea infusion, whereas the proportion of UER entering the GIT decreased progressively (80 to 61%; $P < 0.01$). The amount of urea-N partitioned to the GIT (recycling; 4.1 to 13.2 g/d; $P < 0.0001$) increased with each level, as did the amount excreted in urine (1.0 to 8.6 g/d; $P < 0.0001$). However, the proportion (44 to 69%; $P < 0.001$) and amount (1.8 to 9.2 g/d; $P < 0.0001$) of the GIT entry that returned to the liver for ureagenesis was greater with urea infusion. In consequence, the amount of urea-N used for anabolism (rumen microbial protein synthesis) reached a maximum (2.3 g/d) at the second level of urea infusion. Concurrently, fecal urea-N excretion reached a maximum (1.5 g/d) at the third level of infusion. The present study suggests that the ability of ruminants to partition urea-N to the GIT is less a limitation than the rumen environment. Thus, rather than up-regulating urea entry to the GIT, there appears to be more potential to improve N efficiency of ruminants by manipulating the rumen environment (eg. fermentable energy, pH) for optimal capture of recycled N.

Key Words: Urea Recycling, Ruminant, Metabolism

206 Urea supplementation increased rumen function in lactating dairy cows fed a corn silage based diet deficient in rumen-degradable feed protein (RDP). S. E. Ferguson*, R. S. Ordway, N. L. Whitehouse, P. J. Kononoff, and C. G. Schwab, *University of New Hampshire, Durham*.

Four lactating Holstein cows fitted with ruminal and duodenal cannulae were used in a 4 \times 4 Latin square to determine the efficacy of adding urea to a corn silage based diet on ruminal fermentation and microbial protein synthesis. Dietary treatments were 0, 0.3, 0.6, and 0.9% urea in diet DM; urea was top dressed and manually incorporated into the diet. The basal diet contained (DM basis) 32% corn silage, 16% grass silage, 4% alfalfa hay, 19% corn, 6% barley, 4.5% soybean hulls, 3% citrus pulp, 3% beet pulp, 7% soybean meal, 1.3% ProvAAITM, 1.7% Megalac[®], and 2.7% vitamin/mineral mix. The basal diet was formulated to meet NRC (2001) requirements for energy and all nutrients except RDP. Cows were fed 3 times daily. Experimental periods were 14 d with a 9-d adaptation. Duodenal digesta ($n=16$), rumen samples ($n=16$), and milk samples were

collected over the last 5 d. The consumed diet contained 9.2% RDP in DM and had a predicted RDP balance of -170 g/d (NRC, 2001). Feeding increasing amounts of urea increased mean rumen ammonia N concentrations (9.0, 11.9, 12.8, and 17.4 mg/dl; linear, $P < 0.001$), passage of microbial N (quadratic, $P < 0.01$), and microbial N as a percent of nonammonia N (quadratic, $P < 0.05$). Total ruminal volatile fatty acid (VFA) concentrations ($\mu\text{mole/ml}$) and butyrate as a percent of total VFA increased with increasing urea level (linear, $P < 0.05$); there was a trend for a linear increase in acetate as a percent of total VFA ($P = 0.06$). There were no treatment effects on DM intake (20.8 kg/d), milk yield (32.2 kg/d), milk protein yield (903 g/d), or on ruminal true digestibility of organic matter (59.7%), neutral detergent fiber (41.3%), or acid detergent fiber (47.6%). Urea supplementation increased milk urea N concentrations (11.0, 11.0, 12.5, and 13.2 mg/dl; linear, $P < 0.05$). The results of this study indicate positive effects of adding urea to the described lactating dairy cow diet, and that microbial protein synthesis was maximized at an average rumen ammonia N concentration of 12.8 mg/dl.

Key Words: Lactating Cows, Urea, Microbial Protein

207 Mechanisms of transport of vitamins into colostrum: A potential role of megalin and low density lipoprotein receptor. D. G. Martinez^{*1}, G. E. Dahl², and T. B. McFadden¹, ¹University of Vermont, Burlington, ²University of Illinois, Urbana.

Previous studies have shown that IgG1 is concentrated in ruminant colostrum through active and selective transport by the neonatal Fc receptor (FcRn). It has been speculated that vitamins such as vitamin A and β -carotene are also transported into colostrum through a receptor-mediated mechanism. We hypothesized that the endocytic receptors, megalin and low density lipoprotein receptor (LDL-R), are responsible for transport of vitamin A and β -carotene, respectively. To test this hypothesis, blood samples and mammary secretions were collected from 12 pregnant, multiparous cows and mammary biopsies were obtained on days -40, -20, -7 and +7 relative to calving. Expression of megalin and LDL-R mRNA in biopsy samples were measured by real-time PCR. Expression of α -lactalbumin mRNA was measured as a functional marker of lactogenesis. Concentrations of IgG1 and β -carotene were measured in blood and secretion samples. The mixed procedure of SAS was used for statistical analysis. Expression of megalin and LDL-R mRNA was low at 40 d, peaked during colostrum formation (-7 d; $P < 0.05$) and then declined markedly ($P < 0.01$) during lactation. Expression of α -lactalbumin increased sharply from day -7 to day +7 relative to calving ($P < 0.01$). Plasma IgG1 and β -carotene decreased from 3 weeks before parturition reaching minimal concentrations around parturition ($P < 0.01$). In contrast, IgG1 and β -carotene in secretions increased to maximal concentrations around parturition and then decreased during lactation ($P < 0.01$). Similar patterns have been previously reported for vitamin A. These results imply that, like IgG1, β -carotene and vitamin A are depleted from maternal plasma as they are concentrated in colostrum. Temporal changes in mammary expression of megalin and LDL-R suggest that they may mediate the transfer of these components into colostrum.

Key Words: Colostrum, Megalin, Low Density Lipoprotein Receptor

208 Quantifying the effect of dietary sodium bicarbonate on ruminal pH. N. Singh^{*} and R. A. Kohn, University of Maryland, College Park.

Dairy cattle are fed sodium bicarbonate (NaHCO_3) to reduce fluctuation in ruminal pH. However, we do not know whether NaHCO_3 acts through increasing the cation-anion difference in the rumen or by increasing the liquid turnover rate or volatile fatty acid (VFA) absorption from the rumen. A meta-analysis was conducted using studies where NaHCO_3 was used as a dietary supplement. Treatment means ($n=38$) from 14 studies with ruminally fistulated cows were used to evaluate the effect of dietary NaHCO_3 on ruminal pH, VFA concentration and calculated strong ion difference (SID) of ruminal fluid. The model included levels of NaHCO_3 and the random study effect. Analysis of studies revealed that addition of NaHCO_3 to diet increased ruminal pH ($P=0.0065$) and SID ($P < 0.001$). A decrease in ruminal [VFA] was evident in three studies but was not a general trend across studies. A single compartmental model was fit using two zero-order inputs to the ruminal sodium pool,

(saliva and dietary sodium), and sodium outflow as a first order reaction with respect to rumen sodium concentration [Na]. The model can predict a final ruminal pH of 6.04 on addition of 0.03 moles/l-d of NaHCO_3 for a given initial pH of 5.5. Rumen fractional outflow rate was 0.19/h for sodium ion equivalent (Na^+) equivalent. The model predicted changes in ruminal SID as affected by dietary changes in NaHCO_3 and the changes in ruminal SID were in turn used to predict ruminal pH. There was no significant mean bias or linear bias for SID (RMSPE=0.76) or pH (RMSPE=0.19). Predictions from formulation data set demonstrated that the model accurately estimated rumen [SID] and pH in the data set. Across all studies, addition of NaHCO_3 to the diet increased ruminal pH by increasing ruminal SID, but within 3 studies it decreased rumen [VFA]. The model can be used to predict the effect of dietary NaHCO_3 on rumen pH from a given starting pH.

Key Words: Sodium Bicarbonate, Strong Ion Difference, Ruminal pH

209 Trans-10, trans-12 conjugated linoleic acid (CLA) reduces the Δ^9 -desaturase index without affecting milk fat yield in lactating dairy cows. J. W. Perfield II^{*1}, P. Delmonte², A. L. Lock¹, M. P. Yurawecz², and D. E. Bauman¹, ¹Cornell University, ²Center for Food Safety and Applied Nutrition.

Trans-10, cis-12 CLA is a potent inhibitor of milk fat synthesis and the magnitude of the milk fat depression (MFD) often corresponds to the milk fat content of this CLA isomer. However, in certain situations the *trans-10, cis-12* CLA content of milk fat does not correspond to the MFD observed with some diets and with CLA supplements. An increase in the milk fat content of *trans-10, trans-12* CLA has been observed in some of these situations. In the present study we synthesized *trans-10, trans-12* CLA (purity > 90%) and investigated its effect on milk fat. Three rumen fistulated Holstein cows (168 \pm 80 DIM, mean \pm SE) were randomly assigned in a 3 X 3 Latin square experiment. Treatments were abomasal infusion of 1) ethanol (control), 2) *trans-10, cis-12* CLA supplement (positive control), and 3) *trans-10, trans-12* CLA supplement. CLA supplements supplied 5 g/d of the CLA isomer of interest and the daily dose was provided by infusion at 6 h intervals. Treatment periods were 4 d in length with a 7 d washout interval. Milk yield ($P < 0.69$), DMI ($P < 0.50$) and milk protein yield ($P < 0.50$) were unaffected by treatment. The *trans-10, trans-12* CLA isomer had no effect on milk fat yield whereas *trans-10, cis-12* CLA reduced milk fat yield by 28% ($P < 0.01$). Milk fat content (percent of total fatty acids) of specific CLA isomers was elevated within respective treatment groups, 0.11% for *trans-10, trans-12* CLA and 0.18% for *trans-10, cis-12* ($P < 0.001$). Changes in specific fatty acids indicated that Δ^9 -desaturase was reduced significantly for both CLA treatments, but to a greater extent for the *trans-10, trans-12* CLA treatment. Overall, abomasal infusion of *trans-10, cis-12* CLA altered desaturase ratios and reduced milk fat synthesis, whereas *trans-10, trans-12* CLA altered desaturase ratios but had no effect on milk fat synthesis. This indicates that the mechanism for the reduction in milk fat synthesis by *trans-10, cis-12* CLA does not directly involve the reduction of Δ^9 -desaturase.

Key Words: Conjugated Linoleic Acid, Milk Fat Depression, Stearoyl-CoA Desaturase

210 Altering dry matter intake affects the nutritional efficiency of dairy heifers. G. I. Zanton^{*} and A. J. Heinrichs, The Pennsylvania State University, University Park.

The objective of this experiment was to elucidate the effects of differing intakes of dry matter on the nutritional and nitrogen efficiency in growing, postpubertal dairy heifers. A grass-based, total mixed ration (49.1% NDF, 13.0% CP) was administered to eight rumen cannulated Holstein heifers (340 \pm 5 kg) in a replicated 4x4 Latin square design at levels of intake formulated to equally span the region between maintenance and ad libitum consumption. Treatments consisted of one ration fed at 1.25, 1.50, 1.75, and 2.00 kg per 100 kg body weight with energy being the first-limiting dietary component. Rumen fluid was sampled every two hours for 24 hours and total fecal and urine collection was made over six days. Rumen pH was linearly reduced and total VFA concentration linearly increased as DMI increased ($P < 0.05$), but molar proportions of acetate, propionate, and butyrate and rumen concentrations of ammonia were unaffected by treatment. Bacterial nitrogen flowing to the duodenum, estimated by quantifying the excretion of urinary purine derivatives, was linearly increased by increasing levels of

DMI ($P < 0.05$), however the bacterial nitrogen produced per unit organic matter consumed was not altered by treatment. Organic matter digestibility was linearly increased ($P < 0.05$) by decreasing levels of DMI, while NDF digestibility was unaltered by treatment. Nitrogen excretion in the feces and urine increased linearly ($P < 0.05$) with increasing intake of nitrogen and dry matter. Nitrogen was apparently more digestible for those heifers receiving a lower amount of dry matter compared to those receiving a greater amount ($P < 0.05$). While apparently absorbed nitrogen increased linearly as intake increased ($P < 0.05$), apparently retained nitrogen increased linearly but with a decreasing rate as the intake of dry matter approached the highest level of intake (linear and quadratic, $P < 0.05$). Nitrogen retained as either a proportion of nitrogen consumed or nitrogen absorbed was quadratically affected by treatment ($P < 0.05$) with nitrogen efficiency peaking at intermediate levels of intake.

Key Words: Nitrogen Efficiency, Dairy Heifers, Bacterial Nitrogen

211 The effect of essential plant oils on milk production and composition from lactating dairy cows and on silage fermentation and aerobic stability of corn silage. R. J. Schmidt^{*1}, D. H. Kleinschmit¹, J. M. Ladd¹, J. E. Lynch¹, L. Kung, Jr.¹, P. G. Williams², and R. Losa³, ¹University of Delaware, Newark, ²Akzo Nobel LLC, Davis, CA, ³CRINA S.A. Switzerland.

Alternative feed additives have been studied and the use of plant secondary compounds is a promising option. A blend of essential oil components (CRINA Ruminant, CRINA S.A., Switzerland) was fed to lactating cows to study its effect on intake and milk production. Cows were fed a TMR of 15% alfalfa silage, 10% alfalfa hay, 25% corn silage, and 50% concentrate (DM basis). For a 2-wk pretreatment period all cows were fed 50 g of a limestone/CRINA blend that was mixed into the TMR to provide a daily intake of 0.6 g of CRINA/cow/d. At the start of an 8 wk treatment period cows were blocked on lactation number, pretreatment milk production and days in milk, and randomly allocated to one of two treatments: 1) 100 g of limestone or 2) 100 g of limestone/CRINA (1.2 g CRINA/cow/d). Cows fed CRINA ate 1.9 kg more DM/d and produced 2.7 more kg of 3.5% FCM/d than did cows fed the control diet ($P < 0.05$). Milk composition was unaffected by treatment. CRINA was also added to chopped corn forage (30% DM) to evaluate its effect on silage fermentation and aerobic stability. Treatments were: 1) no additive, 2) 2.5 g of CRINA/25 kg of wet forage, 3) 5.0 g CRINA/25 kg of wet forage, or 4) a buffered propionic acid based product, 4 lb/ton of wet forage (Kemin Industries, West Des Moines, Iowa). After ensiling, addition of CRINA had no effect on silage fermentation or the aerobic stability of corn silage. As expected, addition of the buffered propionic

acid based product increased the concentration of propionic acid ($P < 0.05$) and decreased the yeasts in silage (4.45 vs. 5.16 log cfu/g, $P < 0.05$) but only numerically improved aerobic stability (47.5 vs. 59.5 h) when compared to untreated silage. The findings of this study show that CRINA was unable to affect silage fermentation or aerobic stability but it increased DM intake and milk production in dairy cows.

Key Words: Essential Oils, Milk Production, Silage

212 The effects of *Lactobacillus buchneri* 40788 and damage to the corn ear on the fermentation, aerobic stability, and production of mycotoxins in corn silage. R. S. Teller^{*}, R. J. Schmidt, and L. Kung, Jr., University of Delaware, Newark.

We examined the effects of damaging ears of corn and microbial inoculation on the fermentation, aerobic stability, and production of mycotoxins in whole plant corn silage. Ears of corn on several plants were slashed, exposing damaged kernels to the environment. Seven days later, whole plant corn was harvested at 35% DM and ensiled in 20-L laboratory silos (packing density of 227 kg DM/m³ or 14 lb/ft³) in quadruplicate as one of the following treatments: 1) no inoculation and undamaged ears of corn (CC), 2) inoculation with *L. buchneri* 40788 (400,000 cfu/g of fresh forage) and *Pediococcus pentosaceus* (100,000 cfu/g) (Lallemand Animal Nutrition, Milwaukee, WI) and undamaged ears of corn (IC), 3) no inoculation and damaged ears of corn (CD), 4) inoculation and damaged ears of corn (ID). After 126 d of ensiling, regardless of damage to the ear, inoculated silages had higher concentrations of acetic acid (1.59 vs. 0.87%, $P < 0.05$), lactic acid (4.39 vs. 3.47%, $P < 0.05$), and 1,2 propanediol (0.87 vs. 0.0%, $P < 0.05$) than did uninoculated silages. Inoculated silages had fewer yeasts (0.61 vs. 3.33 log cfu/g) and thus were more aerobically stable (74 vs. 43.3 h, $P < 0.05$) than were uninoculated silages. Although initial numbers of yeasts and molds and concentrations of deoxynivalenol (DON) and fumonisin B1 (FB1) toxins were not different in fresh corn forage, between forage with damaged and undamaged ears, silage with damaged ears had higher concentrations of DON (3872 vs. 1009 ppb, $P < 0.05$) and FB1 (9.05 vs. 4.07 ppm, $P < 0.05$). Silages made from corn with damaged ears tended to have higher concentrations of ethanol (5.40 vs. 4.31, $P < 0.06$). Addition of *L. buchneri* 40788 and *P. pentosaceus* altered silage fermentation and improved the aerobic stability of the corn silage, regardless of damage to the ear before ensiling, but it was not able to prevent an increase in the production of mycotoxins during ensiling.

Key Words: Aerobic Stability, *Lactobacillus buchneri*, Mycotoxins

National ADSA Production Only (Graduate) II

213 Effects of providing supplemental methionine (Met) in the form of SmartamineTM M or 2-hydroxy-4-methylthio butanoic acid isopropyl ester (HMBi) to prepartum and early lactation dairy cows on feed intake and lactational performance. R. S. Ordway^{*1}, N. L. Whitehouse¹, A. M. McLaughlin¹, C. G. Schwab¹, and B. K. Sloan², ¹University of New Hampshire, Durham, ²Adisseo USA, Inc., Alpharetta, GA.

Sixty primiparous (n=18) and multiparous (n=42) Holstein cows were blocked according to parity and expected calving date and assigned randomly to one of three dietary treatments: 1) basal diet, 2) basal diet plus HMBi, or 3) basal diet plus SmartamineTM M. Treatments were initiated 21 d before expected calving and continued through 140 d postpartum. Methionine supplements were added to the diet of each cow in amounts needed to achieve predicted concentrations of Lys (7.19%) and Met (2.37%) in metabolizable protein of 3.0:1.0 (NRC, 2001). It was assumed that 50% of the HMBi in dietary HMBi is converted to metabolizable Met and that 80% of the Met in SmartamineTM M is absorbed. Prepartum DM intake (13.5 kg/d), body weight (687 kg), and body condition score (3.81), and postpartum milk yield (42.0 kg/d), milk fat yield (1549 g/d), milk fat content (3.66%), milk true protein yield (1192 g/d), and milk urea nitrogen content (12.9 mg/dl) were not different among treatments. Postpartum DM intake and body condition score were greater and milk/DM intake and milk N/feed N ratios were less for cows fed HMBi than for cows fed the control and SmartamineTM M diets (22.9 vs. 22.0 and 21.4 kg/d; 3.37 vs. 3.26 and 3.28; 1.92 vs. 2.00 and 1.98; 0.32 vs. 0.33 and 0.34, respectively). Milk protein content

was greater for SmartamineTM M (2.87%) and HMBi (2.81%) than for control (2.72%). Concentrations of Met and Met+Cys in total plasma AA were different among treatments with values for SmartamineTM M being the highest followed by HMBi and control (2.10, 1.43, and 1.15% and 3.92, 3.12, and 2.73%, respectively). The results indicate that both HMBi and SmartamineTM M are effective in providing metabolizable Met, but clarification of their relative contributions to metabolizable Met is still needed.

Key Words: Lactating Cows, Rumen Protected Methionine, Methionine Analogs

214 Comparison of Holstein, Brown Swiss and Jersey cows for age at first calving and first calving interval. T. B. Garcia-Peniche^{*1}, B. G. Cassell¹, I. Misztal², and R. E. Pearson¹, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²University of Georgia, Athens.

The objective of this study was to examine breed differences due to geographic location and birth season on age at first calving and first calving interval, and the effect of season of first calving on first calving interval in Holsteins and Jerseys and Holsteins and Brown Swiss housed on the same farm. Data were analyzed for five (R5) or seven regions (R7) within the United States. The geographic division definition influenced the effect of season of first calving on first calving interval in Holstein-Jersey farms ($P = 0.68$ in R5 and $P < 0.01$ in R7). Holsteins housed with Jerseys (HJ) had shorter first calving intervals and calved at younger

ages than Holsteins housed with Brown Swiss (HB). Data from seven states (California, Oregon, Arizona, Texas, Florida, Ohio and Wisconsin) were also analyzed (S7). In general, Jerseys had the youngest age at first calving and shortest first calving interval, except in the Northwest for age at first calving, and in Florida, Texas and California for first calving interval. Holsteins and Brown Swiss did not differ for first calving interval ($P=0.98$ in R5, $P=0.33$ in R7, and $P=0.09$ in S7). Cows in Texas and Florida had the longest first calving interval (HB 481.4 \pm 20.4, Brown Swiss 448.7 \pm 23.7, HJ 482.9 \pm 20.7, and Jerseys 461.2 \pm 20.9 for Florida, and 487.9 \pm 11.4, 475.9 \pm 11.6, 491.9 \pm 16.1, and 477 \pm 16.8 for Texas, respectively). Brown Swiss had the shortest first calving interval in Texas, Florida and California. Conclusions: Brown Swiss showed evidence of heat stress resistance, the geographic definition affected some of the results, and management practices changed Holsteins' performance depending on their herdmates' breed. Longer calving intervals might not be entirely due to lower fertility, but also due to longer voluntary waiting period to breed the cows.

Key Words: Breed Comparison, Age at First Calving, First Calving Interval

215 One-time oral nucleotides enhance immune function of newborn beef calves. C. E. Oliver*¹, F. Philippe², G. Gaillard², R. B. Danielson¹, W. L. Keller¹, C. Rupprecht³, M. L. Bauer¹, and C. S. Park¹, ¹North Dakota State University, Fargo, ²Ecole Supérieure D'Agriculture D'Angers, France, ³Rabies Laboratory, Centers for Disease Control and Prevention, Atlanta, GA.

The aim of this study was to determine the effect of a one-time oral dose of nucleotides at birth on calf health and immune status. Twelve colostrum-deprived, newborn, beef calves (36.9 \pm 1.4 kg initial body weight) were assigned randomly to either milk replacer only or milk replacer plus nucleotides. Nucleotides were supplemented at 10 times the level found in cow milk (monophosphate form of adenosine = 0.08, cytidine = 2.28, guanosine = 0.96, inosine = 1.28, and uridine = 20.6 μ mol/kg body weight per d). Milk replacer was fed by dry powder weight at 0.7% of the birth weight of each calf. Milk replacer was fed reconstituted with 2 quarts warm water within 2 h of birth. Treatment calves received nucleotides in the milk replacer at the first feeding only. Other feedings in first 24 h for both groups were milk replacer only. Thereafter, calves were allowed to suckle dams. A rabies vaccine was administered at birth. Calves were weighed on d 0, 7, 14, and 21. Scours incidence was scored [2-point scale (0 = normal; 1 = scours)] daily for 3 wk. Morbidity, mortality, and treatment were recorded. Jugular blood was drawn from each calf immediately after birth (prior to feeding or other post-partum processing); at h 6, 12, 24, and 48; and d 7, 14, and 21, and analyzed for glucose, nonesterified fatty acids (NEFA), haptoglobin, immunoglobulins G (IgG) and M (IgM), and rabies vaccine titer. Nucleotide supplementation did not affect ($P \#8805$ 0.25) body weight, scours score, mortality, or serum glucose, NEFA, haptoglobin, or rabies titer. Nucleotide-fed calves tended to have higher IgG levels ($P = 0.08$) than controls (251.7 \pm 26.8 vs 175.0 \pm 28.3 mg/dL). IgM was higher ($P = 0.03$) in nucleotide-fed calves than in controls (70.0 \pm 9.9 vs 34.0 \pm 10.2 mg/dL). Results suggest that a one-time oral dose of nucleotides at birth may enhance immune status of neonatal beef calves by increasing immunoglobulin levels.

Key Words: Nucleotide, Calf, Immune Function

216 Insulin sensitivity in lactating dairy cows and neonatal calves: Comparison of the minimal model and the hyperinsulinemic euglycemic clamp. C. C. Stanley*¹, C. C. Williams¹, H. G. Bateman, II¹, D. T. Gantt¹, J. C. Roberts¹, P. T. Richardel¹, J. C. Lovejoy², and E. Ravussin³, ¹LSU AgCenter, Baton Rouge, LA, ²Bastyr University, Kenmore, WA, ³Pennington Biomedical Research Center, Baton Rouge, LA.

Nine neonatal calves and twelve lactating cows were used to compare the minimal model (MM) computer analysis of the frequently sampled

glucose tolerance test (FSIGT) to the hyperinsulinemic euglycemic glucose clamp (EC) in assessing insulin sensitivity (S_I). During the FSIGT glucose was administered (0.3g/kg BW) followed 20 min later by insulin administration (0.03 IU/kg BW) through a jugular catheter. Blood samples were collected relative to glucose administration for a 6 hr period for measurement of plasma glucose and insulin concentrations which were used in the MM to derive S_I . The EC used a variable rate of glucose infusion to achieve euglycemia (defined as basal glucose concentrations measured prior to the test) while infusing insulin at 1 mU/kg \cdot min⁻¹ in calves or 6 mU/kg \cdot min⁻¹ in cows. Insulin and glucose were infused through a jugular catheter. Blood was collected every 5 min, and glucose concentrations were measured using a handheld glucometer. Glucose disposal rate (GDR) was calculated from the glucose infusion rate after euglycemia was achieved. The GDR was converted to S_I by factoring the change in plasma insulin from basal to hyperinsulinemia and plasma glucose at euglycemia. The S_I from the MM and EC were converted to a common index of insulin sensitivity (S_C). Spearman correlation coefficients were calculated between S_I from the MM and EC. In calves the mean S_C was 0.22 \pm 0.17 and 0.34 \pm 0.21 dL/min \cdot μ U⁻¹ \cdot mL⁻¹ from the MM and EC, respectively. In cows the mean S_C was 0.29 \pm 0.25 and 0.42 \pm 0.15 dL/min \cdot μ U⁻¹ \cdot mL⁻¹ from the MM and EC, respectively. The tests tended to be correlated in calves ($r = 0.42$) but not in cows ($r = -0.08$). The MM and EC do not seem to be directly comparable in cattle and should not be interchanged. Both tests are adequate for measuring differences in S_I when evaluating treatments.

Key Words: Minimal Model, Hyperinsulinemic Euglycemic Clamp, Insulin Sensitivity

217 Effects of colostrum feeding time and sex on serum leptin and fatty acid metabolism in newborn Holstein calves. L. J. Driedger*, J. A. Jackson, K. Meek, and S. T. Franklin, University of Kentucky, Lexington.

Serum leptin has been shown to be negatively correlated to non-esterified fatty acids (NEFA) in adult Holstein cows. Leptin is also a stimulator of the thermogenic capacity of brown adipose tissue, the main source of body heat production earliest in the baby calves life. The objectives of this experiment were to measure the effects of feeding or withholding colostrum and sex on serum leptin and fatty acid metabolism in newborn calves. Eighteen Holstein calves were divided into three experimental groups. Group 1 consisted of 6 male calves that were withheld from colostrum for 12 hours after birth (Not Fed = NF). Groups 2 and 3 consisted of 6 male or 6 female calves that were fed colostrum as soon as they could suckle (Fed Male = FM, Fed female=FF). Immediately after birth, all calves were separated from dams to prevent maternal suckling. Calves were weighed and an initial 0 hour blood sample was drawn. Calves from the FM and FF groups were then fed 2.13 L of maternal colostrum. Additional blood samples were drawn at 3, 6, and 12 hours after feeding. Blood samples were drawn from NF calves at 0, 3, 6 and 12 hours after birth. The NF calves were fed 2.84 L of maternal colostrum immediately following the 12-hour blood sample. Blood was analyzed for serum leptin, NEFA, and β -hydroxybutyrate (BHBA). Data were analyzed using the PROC MIXED procedures of SAS. There were no significant effects of colostrum treatment (NF vs. FM) on serum leptin ($P=.6708$). However, leptin was significantly higher and increased over time for the FF group compared to the FM group at 3, 6, and 12 hours ($P<.01$). Effects of sex were not significant on NEFA for any time period ($P=.7580$) when comparing the FM and FF groups. However, NEFA was significantly lower and decreased over time for the FM group compared to the NF group at 3, 6, and 12 hours ($P<.01$). BHBA concentrations were not different according to sex (FM vs. FF, $P=.8099$), but were significantly higher for the FM group compared to the NF group at the 12 hour sampling time ($P<.0001$). Serum leptin appears to be negatively correlated to NEFA in baby calves from 0 to 12 hours after birth.

Key Words: Calves, Leptin, NEFA

Southern Branch ADSA Graduate Student Paper Competition

218 Effect of length of cut and degree of kernel processing of corn silage on production characteristics of lactating Holstein cows. K. M. Cooke* and J. K. Bernard, *The University of Georgia, Tifton.*

Forty mid-lactation Holstein cows were used in a 9-wk randomized block trial to determine the effect of the degree of kernel processing (KP) and theoretical length of cut (TLC) on nutrient intake and digestibility and milk yield and composition. Corn was harvested at 3/4 milk line stage of maturity at either 1.90 or 2.54-cm TLC. At each TLC, corn was processed at either 2 or 8-mm roll clearance. A control was harvested at 1.90-cm TLC without processing. All treatments were stored in 2.4 m plastic bags and allowed to ferment approximately 5 mo before feeding. Corn silage provided 38% of the DM in the experimental diets which were fed once daily behind Calan doors. No differences in DM or nutrient intake were observed among treatments. Milk yield tended to be higher ($P = 0.07$) for cows fed processed versus unprocessed corn silage (36.0 vs. 35.4 kg/d, respectively). No differences were observed in milk fat (3.88%) or protein (3.10%) due to TLC or KP. However, an interaction between TLC and KP was observed for yield of milk ($P = 0.09$), fat ($P = 0.09$), protein ($P = 0.01$), and energy-corrected milk ($P = 0.03$) because of high yield for cows fed diets containing corn silage processed at 2 mm versus 8 mm at 2.54-cm TLC. Whole tract NDF digestibility tended to be higher ($P = 0.06$) for cows fed processed versus unprocessed corn silage (60.9 vs. 50.1%, respectively) and for animals fed corn silage chopped at 2.54 vs. 1.90-cm (64.4 vs. 54.9%, respectively). Starch digestibility was greater ($P = 0.003$) for corn silage processed at 2 versus 8-mm (92.1 vs. 86.0%, respectively). These results indicate that as TLC increases, the degree of KP becomes more critical for maintaining fiber digestibility and milk yield.

Key Words: Corn Silage, Kernel Processing, Theoretical Chop Length

219 Evaluating the effectiveness of decreasing the dosage of GnRH for ovulation synchronization and timed AI in dairy cows. L. E. McKee*, W. M. Graves, and J. D. Clark, *The University of Georgia, Athens.*

The objective of this study was to determine the effectiveness of decreasing the dose of GnRH (Cystorelin, Merial Limited, Duluth, GA) used in the ovulation synchronization (Ovsynch) protocol. First service lactating Holstein cows ($n=100$) at the University of Georgia Dairy Center in Athens were randomly assigned to 1 of 4 treatment groups (25/trt). All cows received 25 mg of PGF 2α (Lutalyse, Pfizer Animal Health, New York, NY) 11 days (d -11) prior to starting Ovsynch. Cows in treatment 1 received 100 μ g GnRH on day 0, 25 mg PGF 2α on day 7, and 100 μ g GnRH on day 9. Treatment 2 received 50 μ g GnRH on day 0, 25 mg PGF 2α on day 7, and 100 μ g GnRH on day 9. Treatment 3 received 100 μ g GnRH on day 0, 25 mg PGF 2α on day 7, and 50 μ g GnRH on day 9. Treatment 4 received 50 μ g GnRH on day 0, 25 mg PGF 2α on day 7, and 50 μ g GnRH on day 9. All injections were given i.m. Blood samples were collected on days -11 and 0 for progesterone analysis. All cows were artificially inseminated (AI) 16-20 hours after the second GnRH injection. Pregnancy was checked via ultrasound at 35-40 days and 55-60 days after AI. Data was analyzed by Chi Square. The 100 cows averaged 2.3 lactations, 68 days in milk and 88 lb of milk on DHIA. Pregnancy rates at 35-40 days were 52%, 32%, 44%, and 56% for treatments 1, 2, 3, & 4 respectively ($P>.05$, NS). At 55-60 days, the rates were 36%, 28%, 36%, and 48% (NS). Embryonic losses between days 40 and 60 were 16%, 4%, 8%, & 8%. Overall pregnancy rates were 46% at 40 days and 37% at 60 days (NS). A total of 14 of the 100 cows were considered to be noncyclic (both samples < 1.0 ng/ml), and only 2 of these were pregnant at 35-40 days versus 44 of the 86 cyclic cows (either or both samples $> \text{ or } = 1.0$ ng/ml). A total of 28.8% of 28 were pregnant at 55-60 days when the highest temperature-humidity index (THI) on the day bred was $> \text{ or } = 80$, 45.2% of 31 when the THI was between 70-79 and 36.6% of 41 when the THI high was 69 or $<$ (NS). During the 11 months of this study, days open on DHIA decreased 34 days.

Key Words: Ovulation Synchronization, Timed AI, GnRH

Physiology of Lactation

220 Use of serial analysis of gene expression (SAGE) for gene transcript profiling in lactating bovine mammary gland. E. E. Connor*, A. V. Capuco, and T. S. Sonstegard, *USDA-ARS, Bovine Functional Genomics Laboratory, Beltsville, MD.*

Serial analysis of gene expression (SAGE) methodology permits quantitative analysis of global gene expression in a given tissue and is useful for comparison of gene expression patterns across physiological states and identification of novel transcripts. At present, only three SAGE libraries have been produced in cattle from cultured kidney, cultured aorta and immature B cells, and are publicly available in the NCBI SAGEmap database (<http://www.ncbi.nlm.nih.gov/SAGE/>). Our interest is in characterizing gene expression in bovine mammary parenchyma during lactation; however, the disproportionate abundance of milk protein transcripts during this physiological stage hinders the use of microarrays for transcript profiling. To evaluate gene expression during early lactation, a SAGE library was produced from pooled RNA ($n=3$ multiparous Holstein cows) isolated from biopsied mammary parenchyma at approximately Day 7 of lactation. Preliminary sequencing of SAGE tags identified the greatest abundance of α -, β - and κ -casein, α -lactalbumin, β -lactoglobulin and ribosomal protein transcripts, as expected. However, a number of tags corresponding to bovine expressed sequence tags and genes involved in metabolism, intracellular signaling and proteolysis were detected in lower abundance. Our results suggest that SAGE is a feasible approach to study gene expression in lactating mammary gland.

Key Words: Mammary Gland, Gene Expression, Cattle

221 Differential effects of ovarian hormones on epithelial proliferation in the porcine mammary gland. A. S. Barndollar*, J. M. Scudder, J. F. Trott, and R. C. Hovey, *University of Vermont, Burlington.*

Development of the mammary gland (MG) architecture in gilts must occur prior to pregnancy and lactation. Ultimately this development is of major importance as it influences a sows milk production and growth of her piglets. Here we investigated the regulation of cell division in the MG of gilts by ovarian steroid hormones. Based on data from other species, we hypothesized that estrogen (E) would stimulate greater proliferation of mammary epithelial cells compared to progesterone (P). Five-month-old female Yucatan miniature pigs were treated with either E (0.1mg/kg), P (0.25mg/kg) or saline (SAL) by daily sc injection ($n=4$ per group) for five days. Prior to euthanasia, animals were injected with bromodeoxyuridine (BrDU, 5mg/kg), a nucleotide analog incorporated into newly synthesized DNA. MG tissues were sampled, fixed and prepared as paraffin sections. In order to localize dividing cells, an immunohistochemical procedure was developed using a biotinylated anti-BrDU antibody, followed by chromogenic detection of a red precipitate (Vector Red) in nuclei of hematoxylin-counterstained sections. To determine cellular proliferation rates, two hundred cells were counted from each of five ducts in two MGs for each pig. The percent of cells dividing was determined as the proportion of total cells counted that were BrDU-positive. Hormone treatment significantly altered epithelial cell proliferation in the mammary ducts. Proliferation rate following treatment with SAL, E or P was $5.77\pm 1.8\%$, $13.7\pm 8.8\%$ and $1.5\pm 0.9\%$, respectively, indicating that proliferation was increased by E ($P=.007$) and decreased by P ($P=.078$). These changes were also accompanied by alterations in both parenchymal morphology and histology. Taken together, these results indicate a positive effect of E and a negative effect

of P on epithelial proliferation in the MG of gilts. This knowledge may be lead to enhanced mammary growth in gilts and milk production by sows.

Key Words: Mammary Gland, Estrogen, Progesterone

222 Effects of continuous milking and bST on mammary cell proliferation, milk yield and composition in primiparous cows. E. L. Annen*, A. C. Fitzgerald, P. C. Gentry, and R. J. Collier, *University of Arizona, Tucson.*

Continuous milking (CM) of bST-treated cows resulted in no loss of production in multiparous cows, but a 20 to 25% loss in primiparous cows suggesting mammary development in primiparous cows is inhibited by CM. Objectives were to determine effects of CM and bST 1) on mammary epithelial cell (MEC) proliferation during late gestation and early lactation and 2) on milk yield and composition. Primiparous cows were randomly assigned to either continuous (throughout late gestation and early lactation) bST (+bST; n=4) or no bST (-bST; n=4) treatment. Within each animal, udder halves were randomly assigned to CM or a 60-d dry period (CTL) treatment. CTL glands were dried 60 d prior to expected parturition date. CM glands were milked twice daily and yield recorded until parturition or spontaneous dry-off. In the subsequent lactation, daily milk yield and weekly milk composition was measured until 30 d postpartum. Mammary biopsies were taken at -20, -8, +2, +7, and +20 d relative to parturition. CTL+bST and CTL-bST udder halves were dry for 54.4 and 63.3 d and CM+bST and CM-bST halves were dry for 5.6 and 3.1 d due to spontaneous dry-off. Prepartum half-udder milk yield was greater ($P < 0.01$) in +bST cows than -bST cows (11.0 vs. 8.9 kg/d). Postpartum half-udder milk yields (10.6 vs. 22.2 kg/d) were dramatically reduced ($P < 0.01$) in CM halves compared to CTL halves, regardless of bST treatment. Postpartum milk yield in CM and CTL udder halves was not altered by bST treatment. Milk composition (fat, protein, SCC linear score) was not affected by CM or bST treatment. MEC proliferation (Ki67 antigen index) was greater in CM than CTL glands at d -20 (3.7 vs 2.3%; $P < 0.05$), but less at d -8 (4.6 vs. 2.7 %; $P < 0.05$). MEC proliferation was not affected by CM at d +2, +7, and +20 and was not altered by bST at any time point. Results indicate that CM reduced subsequent half-udder milk yield in primiparous cows and MEC proliferation near parturition (-8 d). Negative effects of CM were not overcome by bST supplementation.

Key Words: No Dry Period, Continuous Milking, bST

223 Effects of continuous milking and prostaglandin E₂ on milk yield and composition. E. L. Annen*¹, C. M. Stiening¹, M. E. Dwyer¹, B. A. Crooker², A. C. Fitzgerald¹, and R. J. Collier¹, ¹University of Arizona, Tucson, ²University of Minnesota, St. Paul.

Continuous milking (CM; no dry period) of primiparous cows reduces milk yield in the subsequent lactation regardless of bST treatment while CM of multiparous cows results in no decrease in yield when treated with bST. This parity effect may be caused by CM inhibiting mammary development in primiparous cows. Reduced mammary epithelial cell (MEC) growth has been demonstrated in CM glands. Stimulation of mammary development in CM glands may alleviate reduced milk yields. Prostaglandin E₂ (PGE) in mammary secretions rises during the last 3 wk of gestation and returns to basal levels by 2 d postpartum (PP). This rise in PGE corresponds with a period of rapid MEC growth and differentiation. Prepartum (PR) intramammary infusions (IMI) of PGE were mammary in late-pregnant heifers. The objectives of this study were to determine effects of CM and PGE on milk yield and composition. The study used first or second lactation cows (n=8). Within each cow, udder halves were randomly assigned to CM or a 60-d dry period (CTL) and PP IMI of PGE (+PGE) or no PGE (-PGE). Cows were on study from 67 d PR to 28 d PP. At 60 d PR the CTL udder half was dried. Milk yield was recorded daily and milk composition determined weekly. PGE treatment (875 µg/10 ml medium chain triglyceride oil) was administered by IMI at parturition and at 72 h PP. CTL halves were dry 64.0 d and CM halves were dry 12.6 d as a result of spontaneous dry-off of some CM halves. Milk yield was reduced ($P < 0.01$) in CM udder halves compared to CTL halves (13.2 vs. 22.1 kg/d), but reductions were less substantial in second lactation cows compared to first lactation cows (33% vs. 53%). Milk composition (fat, protein, SCC linear score, and lactose)

was unaltered by CM. No effect of PGE on milk yield or composition was detected in CTL or CM glands. Results confirm that CM reduces milk yield of cows with a mammary growth requirement. Reduced milk yield was not alleviated by PGE suggesting PGE concentrations in CM glands are not limiting mammary growth or milk synthesis.

Key Words: No Dry Period, PGE₂

224 Influence of leptin single nucleotide polymorphism on lactation curve traits for lactating dairy cows. H. W. Soita*, D. A. Christensen, F. C. Buchanan, T. L. Heck, and J. J. McKinnon, *University of Saskatchewan, Saskatoon, SK, Canada.*

DHI test day records of milk production of 48 cows (TT=15, TC=14, CC=19) from the University of Saskatchewan dairy research unit during the years 2000 to 2001 were used to study the influence of leptin single nucleotide polymorphism (C/T transition that results in an Arg25Cys)) on lactation curve traits. Phenotypic traits of the milk yield lactation curve were estimated by fitting Woods (1967) gamma function to data recorded monthly by DHI. The traits of interest included rates of incline to reach peak yield b, rates of decline after peak yield c, peak yield, days to peak yield, persistency and total yield. Only data from animals with lactation period over 280d were included. The genotype structure of the herd based on leptin SNP showed that of the 134 cows genotyped 27.6, 44.0 and 28.4 % were TT, TC and CC respectively. Days to peak yield was defined as b/c, Peak yield was calculated as a (b/c)^{be}-b, persistence was calculated as -(b+1)ln(c). The area under the lactation curve was taken to represent the total yield of the 305d lactation. The influence of leptin SNP on lactation curve's rate of incline, days to peak and persistency depended on parity. The TT/TC cows in their first lactation exhibited steeper ($P < 0.05$) incline rates consequently they (TT/TC) reached peak lactation earlier ($P < 0.05$) as compared to the CC. Persistency tended to be higher ($P < 0.1$) for the first calf TT/TC cows as compared to the CC. Similarly total 305-d lactation milk yield showed trends for higher yields for the TT/TC younger cows. We also note here that total 305-d milk yield is negatively correlated with rate of decline c implying that the TT/TC cows with less steep decline have higher milk production potential. It is concluded that a phenotypic variation with reference to lactation curve exists due to the leptin SNP in dairy cows in the first lactation.

Key Words: Leptin SNP, Lactation Curve

225 Identifying positive effectors of milk protein synthesis: amino acids and glucose. C. A. Toerien*, D. R. Trout, and J. P. Cant, *University of Guelph, Guelph, ON, Canada.*

In eukaryotic cells, nutrients play an important role in activating the cell signalling cascades that regulate protein synthesis. To assess the effect of amino acids and glucose in the mammary gland, Holstein cows were fasted to quench protein synthesis before re-supplying nutrients. In a 6x6 Latin Square design, cows (initial: 69±4 DIM; 43.4±0.5 kg milk/d) were subjected every 14 d to a 31-h fast. For the last 9 h of the fast, cows were infused iv with EAA+Glc (positive control), Glc, Met+Lys, His, Leu, or saline (Sal; negative control). Blood samples were collected at 1 d, -1 min and hourly during the infusion, and at +1 d. Milk production response to infusion was calculated from milk produced in the front quarters between +1 and +7 h of the 9-h infusion. At +9 h, an approximately 1.5-g biopsy sample of mammary tissue was harvested from a hindquarter (HQ). In successive periods, HQs were alternated so that each HQ was allowed 28 d to recover. Post-biopsy, cows were refed and infused with AA+Glc for 5 h. Relative to Sal, infusion of EAA+Glc increased ($P < 0.05$) total milk, lactose and protein yields by 83, 106 and 45% respectively. Infusion of glucose alone resulted in similar responses (83, 98 and 41% respectively; $P < 0.05$), implicating Glc as a powerful activator of protein synthesis. Infusion of His elevated milk (29%) and lactose (36%) yields above Sal ($P \# 88040.07$). Met+Lys-, His- and Leu-stimulated protein yields did not differ from Sal ($P > 0.05$). Nor did His-stimulated protein yield differ from EAA+Glc ($P > 0.05$). The effect of His on protein yield equalled 57% of the effect of EAA+Glc, which was far greater than its 5% proportion in the EAA of the EAA+Glc infusate. In conclusion, both glucose and His affected changes in milk synthesis

that implies responses in signal cascades in the mammary epithelial cell.

Milk	Treatments					
	Sal	EAA+Glc	Glc	Met+Lys	His	Leu
Total, kg	1.71 ^a ±0.1	3.13 ^b ±0.1	3.13 ^b ±0.1	2.06 ^a ±0.1	2.2 ^a ±0.1	1.95 ^a ±0.1
Lactose, g	69 ^a ±4.9	141 ^b ±5.7	136 ^b ±5.5	83 ^a ±5.5	93 ^a ±5.6	84 ^a ±5.3
Protein, g	59 ^a ±2.8	82 ^b ±3.3	80 ^b ±3.2	67 ^a ±3.2	71 ^{ab} ±3.2	61 ^a ±3
Fat, g	132 ^a ±7.7	147 ^a ±9	163 ^a ±8.7	143 ^a ±8.8	150 ^a ±8.9	153 ^a ±8.4

a,b,c Significance ($P < 0.05$)

Key Words: Milk Protein Regulation, Amino Acids, Glucose

226 Cloning and expression of bovine glucose transporter GLUT8. F. Zhao*, P. Miller, E. H. Wall, Y. Zheng, B. Dong, and T. McFadden, *Lactation and Mammary Gland Biology Group, Department of Animal Science, University of Vermont, Burlington.*

GLUT8 is a new member of the facilitative glucose transporter family, exhibiting high-affinity glucose transport activity. The expression of GLUT8 has been shown to depend on gonadotropin secretion and may be regulated by insulin. To study the role of GLUT8 in glucose uptake and maintenance of glucose homeostasis in lactating bovine tissues, we cloned and sequenced the full length cDNA of bovine GLUT8 (GenBank accession no. AY208940) by RACE (rapid amplification of cDNA ends). The 2073 base pair cDNA sequence is predicted to encode a protein of 478 amino acids, with a molecular weight of approximately 51 kDa. The deduced amino acid sequence of bovine GLUT8 has 90%, 84%, 84% and 58% identity to human, mouse, rat and chicken GLUT8, and is 26%, 27% and 24% identical with bovine GLUT1, GLUT3 and GLUT4. Bovine GLUT8 retains the characteristic structural features of GLUT8 proteins previously identified from other species including membrane spanning helices, glucose transporter motifs, an N-linked glycosylation site on loop 9 and a putative dileucine internalization motif. The major in vitro transcription and translation product of bovine GLUT8 cDNA migrated at an apparent molecular weight of 38 kDa similar to the sizes reported for GLUT8 from other mammalian species. In the presence of canine microsomal membranes, the translation product increased to 40 kDa suggesting glycosylation. Transient transfection studies in COS-7 and MAC-T 11A cells using a FLAG epitope tagged construct revealed that bovine GLUT8 is localized to the cytoplasm in non-stimulated conditions. A 2.1 kb GLUT8 mRNA transcript was detected at the highest levels in bovine testes, at medium levels in lactating bovine mammary gland, lung, kidney, spleen, intestine and skeletal muscle, and at lower levels in bovine liver. GLUT8 mRNA expression in bovine mammary gland increased about ten-fold ($P < .001$) during late pregnancy and early lactation, similar to changes in expression of GLUT1. These results indicate that GLUT8 expression may be regulated by lactogenic hormones and GLUT8 may play a role in glucose uptake in the lactating bovine mammary gland.

Key Words: Glucose Transport, Glucose Uptake, Mammary Gland

227 Effects of a shorter duration of photoperiod treatment during the dry period on cellular immune function in dairy cattle. T. L. Auchtung*, E. D. Reid, D. E. Morin, and G. E. Dahl, *University of Illinois, Urbana.*

The periparturient period is a time of increased immunosuppression and risk of mastitis in cows. Previously, our laboratory has observed an enhanced cellular immune function in cows treated with short day photoperiod (SDPP) while dry, relative to long day photoperiod (LDPP). However, comparisons have not been made with natural photoperiod, or with further manipulations of photoperiod during the dry period. The objective of this experiment was to determine the effect of natural photoperiod during the dry period on cellular immune function, relative to current photoperiod management practices. In addition, we were interested in investigating the effects of modifications of the standard SDPP during the dry period. Holstein cows ($n = 30$) were assigned randomly to one of four dry period treatments: LDPP (16 h light: 8 h dark), SDPP (8 h light: 16 h dark), AMB (natural lighting schedule during dry period), and SD21 (AMB until 21 d prepartum followed by SDPP). After parturition, cows were exposed to AMB. Blood was collected at dry off and every 4 wk until 21 d prepartum, at which time sampling occurred weekly until calving. Mitogens used were concanavalin A and pokeweed mitogen. Neutrophil chemotaxis was measured in response to interleukin-8. At dry off, there was no difference for either lymphocyte proliferation or neutrophil chemotaxis. After 4 wk on treatment, SDPP

had enhanced ($P < 0.05$) neutrophil chemotaxis and lymphocyte proliferation than cows on LDPP or AMB. Cows on SD21 at 4 wk were on the same photoperiod treatment as AMB and had similar responses to AMB and LDPP groups. In conclusion, SDPP improves cellular immune function compared with both LDPP and AMB treatments. These data suggest that SDPP has beneficial effects on cellular immune function during the first month of the dry period, whereas LDPP has no effect on immune function of the dry period. The consequences of shortening the duration of SDPP during the dry period on immune function is being examined.

Key Words: Cattle, Photoperiod, Immune Function

228 Comparison of gene expression changes in the two subunits of bovine IgG1 receptor during colostrogenesis. D. G. Martinez*, R. Thomason, and T. B. McFadden, *University of Vermont, Burlington.*

Massive transfer of IgG1 into bovine colostrum is mediated by the mammary Fc receptor. This receptor consists of two light and two heavy chains, β_2 -microglobulin and FcRn, respectively. Previous studies have suggested that FcRn is up-regulated three weeks before parturition to facilitate the transfer of plasma IgG1 into colostrum. Conversely, another study has reported that β_2 -microglobulin is the regulated component of the receptor. To resolve this discrepancy we quantified changes in gene expression of the two units of FcRn receptor in heifers undergoing colostrum formation. Twelve non-pregnant Holstein heifers were fed melengesterol acetate (.5 mg/day) for 14 d to synchronize estrus and were then induced into lactation by treatment with estrogen and progesterone (E+P; .1 and .25 mg/kg/d) for 7 d. Twice-daily milking was initiated 21d after the initial E+P injection. Mammary biopsies were obtained at 0, 5 and 10 d relative to the initial E+P treatment. Gene expression of FcRn and β_2 -microglobulin in mammary tissue was measured by quantitative real time PCR and normalized to β -actin mRNA expression. IgG1 concentrations were determined in plasma and secretion as colostrogenesis markers. Circulating IgG1 concentrations began to decrease from about day 5 (3.7 ± 3 mg/ml) relative to the initial injection of E+P to reach a minimum around day 12 (2.8 ± 3 mg/ml; $P < .01$). A high concentration of IgG1 in secretions was detected on day 12 (54.6 ± 4.3 mg/ml) and then decreased progressively through the initiation of milking (14.9 ± 3.5 mg/ml; $P < .01$). Abundance of β_2 -microglobulin mRNA did not change over time ($P > .05$). In contrast, FcRn gene expression increased about tenfold on day 5 ($P < .01$), coinciding with the initial decrease of plasma IgG1, and then declined about sixfold by day 10 ($P < .01$). We conclude that FcRn (heavy chain) is the hormonally regulated unit of the bovine mammary epithelial Fc receptor during colostrum formation whereas β_2 -microglobulin is constitutively expressed.

Key Words: FcRn, β_2 -Microglobulin, Colostrum

229 Changes in expression of vitamin receptors in bovine mammary gland during hormone induced colostrogenesis. D.G. Martinez*, R. Thomason, and T.B. McFadden, *University of Vermont, Burlington.*

The objective of this study was to quantify changes in gene expression of megalin, low-density lipoprotein receptor (LDL-R) and folic acid receptor during hormone-induced colostrum formation to determine whether they may be involved in the transport of their ligands (vitamin A, β -carotene and folic acid) from maternal circulation into colostrum. Twelve non-pregnant Holstein heifers were fed melengesterol acetate (0.5 mg/day) for 14 d to synchronize estrus and were then induced into lactation by treatment with estrogen and progesterone (E+P; .1 and .25 mg/kg/d) for 7 d. Twice-daily milking was initiated 21d after the initial E+P injection. Mammary biopsies were obtained at 0, 5 and 10 d relative to the initial E+P treatment. β -carotene concentrations were determined in plasma and mammary secretions as an indicator of colostrogenesis. Concentrations of α -lactalbumin in plasma were measured for use as a functional marker of lactogenesis. Expression of megalin, LDL-R, and folic acid receptor mRNA in mammary tissue was determined by quantitative real time PCR and normalized to β -actin mRNA expression. Plasma β -carotene concentrations declined between -2d (3.6 ± 3 ug/ml) and 10d (3.1 ± 3 ug/ml; $P < .01$) relative to initial E+P injection, indicating colostrum formation. Concentrations of β -carotene in mammary secretions averaged $.78 \pm .09$ ug/ml at 12d, then decreased through the initiation of milking ($.49 \pm .08$ ug/ml;

$P < .01$). Plasma α -lactalbumin concentrations increased about fivefold from 10d to 15d ($P < .01$), indicating onset of lactation. Megalin expression increased about 3-fold from 0d to 5d ($P = .01$), then decreased 2.8-fold by 10d ($P = .01$). Gene expression of LDL-R decreased 4.5-fold ($P < .06$) from 5d to 10d while folic acid receptor mRNA decreased about twofold ($P < .05$). We conclude that temporal changes in expression of

megalin, LDL-R and folic receptor mRNA during colostrogenesis may be related to the transport of their ligands into colostrum. Hormonal induction of lactation provided a useful model for studying the regulation of colostrogenesis.

Key Words: Colostrum, Vitamins, Induced Lactation

Meat Science and Muscle Biology

230 Conjugated linoleic acid (CLA) concentrations in beef tissues from cattle finished on pasture initially with limited grain. R. N. Sonon Jr.*¹, D. C. Beitz¹, A. H. Trenkle¹, J. R. Russell¹, and R. Rosmann², ¹Iowa State University, Ames, ²Rosmann's Family Farms.

Thirty Red Angus cross yearling steers and heifers (initial BW = 394 ± 54 kg) were fed to choice grade in an on-farm study to compare the concentrations of CLA in beef tissues and to evaluate beef quality of cattle finished on pasture initially or on drylot diet entirely. The cattle on the pasture group grazed by rotation forages consisting primarily of endophyte-free tall fescue grass for 207 d and then, were shifted to the drylot diet for 59 ± 15 d, whereas the drylot cattle were fed ground alfalfa-orchardgrass hay for 183 ± 16 d. In addition to the basal forage, a corn-soybean concentrate mixture was fed at 0.5 to 1.0% of BW to the pasture group of cattle while grazing, and at 2.0% of BW to the drylot group of cattle. After harvest of cattle, steaks were removed from the 12th-13th rib of the carcasses of sixteen animals for fatty acid analysis and sensory evaluation. Results showed that cis9, trans11 CLA concentration in ribeye steak of pastured cattle (0.44 g/100 g of fatty acids) was significantly higher ($p = 88040.05$) than in steak of cattle fed the drylot diet (0.17 g/100 g of fatty acid). Linolenic acid (C18:3n-3) concentration in ribeye steak of pastured cattle (0.79 g/100 g of fatty acids) was significantly higher ($p = 88040.05$) than in the ribeye steak of drylot cattle (0.61 g/100 g of fatty acids). The Warner-Bratzler shear test of tenderness of ribeye steak from pasture-fed cattle was 2.85 ± 0.61 kg and did not differ with that of the drylot cattle (2.60 ± 0.65 kg). Sensory evaluation of ribeye steaks (pasture vs drylot) included juiciness (5.83 vs 5.43), tenderness (6.61 vs 7.00), chewiness (3.14 vs 2.43), flavor (2.08 vs 2.43) and off-flavor (5.56 vs 5.55) and these attributes were not different ($p > 0.05$) between the two groups of cattle. Data from this on-farm study indicate that pasture-feeding contributed to the production of a potentially healthier beef without diminishing eating qualities.

Key Words: CLA, Beef Quality, Pasture

231 Effects of two supplementation levels of linseed combined with CLA or tallow on meat quality traits and fatty acid profile of adipose tissue and longissimus muscle in pigs. G. Bee*, S. Jacot, G. Guex, and W. Herzog, *Swiss Federal Research Station for Animal Production and Dairy Products 1725 Posieux, Switzerland.*

Linseed is an efficient dietary supplement to increase 18:3n-3 concentration in meat and adipose tissue in pigs. Increased concentration of highly unsaturated PUFA can lead to quality deterioration due to lipid oxidation. We hypothesize that inclusion of conjugated linoleic acids (CLA) or tallow could limit the potential for lipid oxidation. In the present study we evaluated the effect of CLA or tallow combined with linseed on carcass characteristics, longissimus muscle (LM) quality traits, and the fatty acid profile of the LM and adipose tissue. From 18 to 104 kg BW, 32 Swiss Large White barrows were fed a grower finisher diet supplemented either with: 1) 3% linseed (L3); 2) 2% linseed (L2); 3) 2% linseed + 1% CLA (L2C); or 3) 2% linseed + 1% tallow (L2T). The amount of omental fat was higher ($P < 0.05$) in the L3 (2.09%) compared to the L2 and L2T group (1.60% for each). Initial pH in the LM was higher ($P < 0.05$) in the L2T (6.30) compared with the L2 (6.06) and L2C (6.03) group, but did not differ from the L3 group (6.14), whereas no dietary effects were observed for ultimate pH, color, drip, cooking losses, and shear force values. Inclusion of CLA (L2C) did not affect PUFA level but increased ($P < 0.05$) the concentration of saturated and decreased ($P < 0.05$) that of monounsaturated fatty acids in the tissues compared to the other treatments. Neither CLA nor tallow altered the concentration of 18:3n-3, 20:3n-3, 20:5n-3, and 22:5n-3 compared to the L2 group. Consequently, in the 3 dietary groups the n-6/n-3 ratio was similar in the LM (2.9) and adipose tissue (3.6). As expected, the higher linseed supply (L3) resulted in increased ($P < 0.05$) 18:3n-3 and

20:3n-3 concentrations in the tissues, whereas from the higher unsaturated fatty acids of the n-3 family only 22:5n-3 level was increased ($P < 0.05$) in the adipose tissue compared to the L2, L2C, and L2T group. The present results indicate, that CLA, but not tallow, combined with linseed could help reduce the potential for lipid oxidation by decreasing the unsaturation level without affecting the improved n-6/n-3 ratio.

Key Words: Linseed, CLA, Pig

232 Consumer acceptance of beef from steers finished on ryegrass forage or a high-concentrate diet. C. R. Kerth*, K. W. Braden, R. B. Cox, and J. Alexander, *Department of Animal Sciences, Auburn University, Auburn, AL.*

Charlais-Angus crossbred steers were fed one of three finishing diets to determine consumer acceptance of forage-fed or concentrate-fed beef. When steers ($n = 30$) reached 340 kg, they were randomly assigned to one of three finishing treatments consisting of ryegrass only for 178 d (RG), ryegrass for 125 d followed by 98 d of a high-concentrate, feedlot-type diet (RGC), or a high-concentrate, feedlot-type diet for 82 d (CON). Steers from RGC and CON groups were harvested when estimated backfat thickness reached 1.0 cm and steers from the RG group were harvested when the amount of forage was insufficient to maintain animal growth. To determine consumer acceptance, 153 consumers at an outdoor festival in Auburn, AL were asked to taste steaks from each of the three treatments. Boneless, strip loin steaks were cooked (71C) on clam-shell-style electric grills, cut into 1.0 X 1.0 cm cubes and placed in double boilers kept warm over a small flame. Overall acceptability scores were determined by marking an "X" on a continuous line anchored with frowning (score of 0) and smiling (score of 100) faces and scored by interpolation. Pricing acceptability was determined in the same manner with \$7.46/kg and \$16.26/kg anchoring the line and \$11.86/kg as the midpoint of the line, representing the typical market value of a strip loin steak at the time. Consumers were then asked which steak they preferred. The demographics of those participating in the survey were evenly distributed across income levels and gender, with almost half (46.6%) being younger than 30 y and the remainder evenly distributed from 31-80 y of age. Overall acceptability scores and price per pound were higher ($P < 0.05$) for steaks from cattle finished on CON compared to steaks from cattle finished on RG or RGC. Additionally, a higher ($P < 0.05$) percentage of consumers preferred steaks from CON (63.9%) compared to RGC (13.9%) or RG (22.2%). Consumers that preferred RG beef were willing to pay \$1.17/kg more for RG beef compared to CON beef. These results indicate that a significant market exists for forage-fed beef and consumers are willing to pay a premium for it.

Key Words: Grass-Fed Beef, Consumer Acceptance, Price

233 Mechanisms of beef carcass tenderness. R. Johnson*, J. Sawdy, J. M. Reddish, M. S. Uptide, and M. Wick, *The Ohio State University, Columbus.*

This study advanced a model that was developed to investigate the potential for relating changes in electrophoretic protein patterns derived from the L. dorsi of beef cattle 36 hr postmortem with tenderness at 7 d. Previous research done in this lab showed a significant association ($R^2 = 0.82$) between tenderness at 7 days, as determined by Warner Bratzler Shear analysis, and the relative intensities of 7 bands from L. dorsi myofibrillar fingerprints of proteins/peptides derived from the same tissue at 36 hr postmortem. Mass spectrometric analyses was used to identify one of the bands, significantly associated with tenderness, as bovine fast myosin light chain-1 (bMLC1) ($P < 0.001$). The method was previously used to identify fragments of bovine myosin heavy chain as being associated with tenderness. These combined findings suggest the presence of at least two distinct mechanisms contributing to tenderness. One mechanism proposes a relationship between myosin heavy chain proteolysis and tenderness. The most recent finding indicates a positive correlation with the amount of intact bMLC1 and tenderness.

This information has the potential of increasing our understanding of the mechanisms regulating beef carcass tenderness.

Key Words: Proteomic Fingerprinting, Beef Tenderness, Myosin Light Chain 1

234 Effects of ractopamine and dietary fat source on performance and carcass characteristics of growing-finishing swine. J. K. Apple^{*1}, B. R. Kutz¹, C. V. Maxwell¹, M. E. Davis¹, L. K. Rakes¹, Z. B. Johnson¹, and T. A. Armstrong², ¹University of Arkansas, Fayetteville, ²Elanco Animal Health, A Division of Eli Lilly and Company, Greenfield, IN.

To test the interactive effects of ractopamine (RAC) and dietary fat source on performance and carcass characteristics, crossbred pigs (n = 216) were blocked by BW (78.1 ± 6.5 kg), and allotted randomly to pens (6 pigs/pen). After a 1-wk adjustment period when a common diet devoid of RAC was fed, pens within blocks were assigned randomly to 1 of 4 dietary treatments arranged in a 2 × 2 factorial design with 5% fat (beef tallow or soy oil) and RAC (0 or 10 mg/kg). All diets were formulated to contain 3.1 g lysine/Mcal of ME and 3.48 Mcal/kg of ME. Individual pig weights and feed disappearance were recorded weekly to calculate ADG, ADFI, and G:F. At conclusion of the 35-d finishing period, pigs were slaughtered at a commercial pork packing plant, and carcass weight, 10th rib fat and LM depths, and fat-free lean yield (FFLY) were recorded prior to chilling. During fabrication, right-side loins were collected for pork quality determinations. Across the entire trial, pigs fed RAC had greater (P < 0.001) ADG and G:F, but RAC did not affect (P > 0.10) ADFI. Neither tallow nor soy oil affected (P > 0.10) pig performance. Carcass weight, LM depth and FFLY were increased (P < 0.002), whereas fat depth was decreased (P < 0.06), in carcasses from RAC-fed pigs; however, carcass composition measures were similar (P > 0.10) between fat sources. The LM from pigs fed RAC had higher pH values (P < 0.01) and received higher American (P < 0.01) and Japanese (P < 0.04) color scores. Although L* values were not affected (P > 0.10) by RAC, the LM from RAC-pigs had lower a* (P < 0.002) and b* (P < 0.005) values. The LM of pigs fed soy oil received higher (P < 0.05) American color scores than pigs fed tallow; otherwise pork quality was not (P > 0.05) affected by dietary fat source. Pigs fed RAC and beef tallow had higher (P < 0.05) marbling scores than all other treatment combinations (RAC × fat source; P < 0.04). Results indicate that feeding 10 mg/kg RAC will improve rate and efficiency of gain, carcass composition, and LM quality; however, dietary fat source had little to no impact on performance or carcass composition and quality.

Key Words: Dietary Fat, Pork Quality, Ractopamine

235 Effects of ractopamine and dietary fat source on quality characteristics of fresh pork bellies. J. K. Apple^{*1}, B. R. Kutz¹, C. V. Maxwell¹, M. E. Davis¹, L. K. Rakes¹, Z. B. Johnson¹, and T. A. Armstrong², ¹University of Arkansas, Fayetteville, ²Elanco Animal Health, A Division of Eli Lilly and Company, Greenfield, IN.

To test the interactive effects of ractopamine (RAC) and dietary fat source on fresh pork belly quality, bellies (n = 167) from pigs fed 1 of 4 dietary treatments arranged in a 2 × 2 factorial design with 5% fat (beef tallow or soy oil) and RAC (0 or 10 mg/kg), were collected during carcass fabrication. Subjective belly firmness was measured using the bar-suspension method by measuring the distance between belly ends when the length of the belly was suspended perpendicular (skin-side down and up) and parallel (skin-side up) to the bar. Color (L*, a*, and b* values) of the rectus abdominus muscle and belly fat was measured, and two 5.1-cm diameter cores were removed from the center of each belly. Cores were subsequently compressed 50% their thickness with an Instron testing machine equipped with a 400-kg load-cell and a crosshead speed of 100 mm/min. There were no (P > 0.10) interactions between RAC and dietary fat source for any pork belly quality trait. Neither RAC nor fat source affected (P > 0.10) belly thickness. Subjective (bar-suspension) or objective (compression test) measures of belly firmness were not (P > 0.05) affected by the inclusion of RAC in the diet; however, bellies from pigs fed soy oil were softer (P < 0.01) than those from pigs fed tallow, as indicated by perpendicular suspension (11.66 vs. 15.40 cm, skin-side down, respectively; 17.58 vs. 20.70 cm, skin-side up, respectively) and parallel suspension (16.04 vs. 19.50 cm, respectively). Additionally, bellies from tallow-fed pigs required more (P < 0.01) force to compress 50% their thickness than bellies from soy oil-fed pigs (52.47 vs. 43.02 kg, respectively). Neither lean nor fat color was affected (P > 0.10) by RAC, and fat source had no (P > 0.10) effect on

lean color. However, the belly fat of pigs fed tallow was lighter (higher L* values; P < 0.04) and redder (higher a* values; P < 0.02) than the fat of bellies from pigs fed soy oil. Results of the present study indicate that, as expected, dietary fat source impacts the firmness of fresh pork bellies; however, feeding RAC during the late-finishing period does not affect the firmness and color of fresh pork bellies.

Key Words: Dietary Fat, Pork Bellies, Ractopamine

236 Effect of slaughter weight on pork quality of castrated females. J. Peinado^{*1}, D. García², F. Baucells¹, G. G. Mateos³, and P. Medel¹, ¹Imasde Agropecuaria Madrid, Spain, ²Estación Tecnológica De La Carne De Guijuelo Salamanca, Spain, ³Universidad Politécnica De Madrid Madrid, Spain.

A total of 150 Pietrain*Large White × Landrace*Large White females of 23.3 ± 1.5 kg of initial BW were used to study the influence of slaughter weight (SW) on meat quality. Females were castrated at 30 kg BW and slaughtered at 105, 115 or 120 kg BW. Each of three treatments was replicated five times (ten pigs housed together). Feeding program was common for all the pigs and consisted of three diets offered *ad libitum* (2.3, 2.4, and 2.4 Mcal NE/kg and 0.97, 0.70, and 0.67 % lys from 30 to 65, 65 to 95, and 95 kg BW to slaughter, respectively). At 45 min postmortem, *longissimus* muscle samples were obtained from the last rib from four pigs per replicate. Intramuscular fat content and Warner-Bratzler force of loins were determined by using a Near Infrared Transmittance meat analyzer and a texture meter, respectively. Loins from pigs slaughtered at 120 kg BW had more intramuscular fat and higher shear force values than loins from pigs slaughtered at 105 kg BW, with loins from pigs slaughtered at 115 kg BW in an intermediate position (1.99, 2.50, and 2.70 % of intramuscular fat and 6.34, 6.57, and 7.24 kg of Warner-Bratzler values for 105, 115, and 120 kg BW; P < 0.05 and P < 0.10, respectively). Defrosting and cooking losses decreased with SW (12.8, 9.2, and 11.7 %, P < 0.05; 26.0, 24.9, and 24.4 %, P < 0.10, for 105, 115, and 120 kg BW, respectively). Increasing SW increased meat color (a* value of 3.42, 4.78, and 5.07 for 105, 115, and 120 kg BW, respectively; P < 0.05). In addition, linoleic acid content of subcutaneous fat was higher for pigs slaughtered at 105 kg BW than for pigs slaughtered at 115 or 120 kg BW (11.56, 10.64, and 10.10 % for 105, 115, and 120 kg BW, respectively; P < 0.05). It is concluded that increasing slaughter weight from 105 to 120 kg improves intramuscular fat content and color of meat from heavy pigs destined to the dry-cured industry.

Key Words: Pork Quality, Castration, Slaughter Weight

237 Strategies based on gender and slaughter weight to modify carcass quality for cured product industry. J. Peinado^{*1}, A. Fuentetaja², J. Sánchez¹, G. G. Mateos³, and P. Medel¹, ¹Imasde Agropecuaria Madrid, Spain, ²CIPIESE Segovia, Spain, ³Universidad Politécnica De Madrid, Madrid, Spain.

A total of 336 Duroc × Landrace*Large White pigs of 28.4 ± 2.3 kg of initial BW were used to study the influence of sex (castrated females, CF; entire females, EF; castrated males, CM) and slaughter weight (SW) (119 vs 131 kg BW) on productive performance and carcass quality. Each treatment was replicated four times (14 pigs housed together). Males were castrated at birth and females at 30 kg BW. All pigs received a common feeding program that consisted of three diets offered *ad libitum* (2.3, 2.4, and 2.4 Mcal NE/kg and 0.97, 0.70, and 0.67 % lys, from 30 to 60 kg BW, 60 to 90 kg BW, and 90 kg BW to slaughter). For the whole period, neither gender nor SW affected productive performance, although CM and CF pigs ate 4 % more and had 4 % worse feed conversion rate than EF. Backfat and fat thickness at *Gluteus medius* muscle (GM) were greater for CF than for EF or CM (31.4, 25.2, and 28.7 mm at P2, and 20.7, 18.1, and 18.7 mm at GM for CF, EF, and CM, respectively; P < 0.05). The percentage of pigs with a fat thickness at GM equal or greater than 20 mm was 70, 42, and 48 % for CF, EF, and CM, respectively (P < 0.05). In addition, backfat thickness increased 19 % when SW increased from 119 to 131 kg (P < 0.05). Loin yield was greater for EF than for CM, with an intermediate value for CF (7.13, 7.22, and 6.91 % for CF, EF and CM, respectively; P < 0.05). It is concluded that castration of females and increasing SW from 119 to 131 kg improves carcass fat content without impairing productive performance of pigs destined to produce cured hams.

Key Words: Carcass Quality, Pig Performance, Castration

238 Evaluating the fatty acid distribution of bratwurst in retail products and of fat in Fertiliium treated sows. L. Gordon*, A. Cox, A. Schinckel, and M. Latour, *Purdue University, West Lafayette, IN.*

The objective in Experiment 1 was to investigate the fatty acid distribution of fourteen different brands of bratwurst available in retail stores. For Experiment 2, the investigators examined the fatty acid profile in the middle and outer fat layers of sows which were fed either a control diet (n=5) or a diet enriched with Fertiliium (n=5), a supplement added to swine diets in low concentration and contains a protected n3 polyunsaturated fatty acid source. Results of Experiment 1, suggest that major fatty acids (C16:0, C18:0, C18:2, as well as the n6/n3 ratio and iodine value [IV]) varied significantly (P<0.01) between brands. The levels C16:0, C18:0, C18:2, n6/n3 ratio and IV ranged between 20-27%, 33-41%, 9-19%, 8:1-37:1 and 53-70, respectively. Collectively these results would suggest that retail brand of bratwurst exhibit tremendous variability in fatty acid composition. In Experiment 2, there were significant differences (P<0.03) in the fatty acid distribution between control and Fertiliium enriched sows as well as between fat layers; more specifically and across both fat layers, enriched sows displayed a significantly lower (P<0.05) n6/n3 ratio when compared to controls. Furthermore, control sows displayed a significantly higher (P<0.05) level of n6/n3 ratio in the outer layer when compared to the middle layer. These data would suggest that enriched sows display a fatty acid profile unlike controls and may provide a better source of n3 fatty acids in ultimate products.

Key Words: Fat, Bratwurst, Sows

239 Fascicular structure as a quantitative trait for bovine and ovine skeletal muscles. G. S. Harper*¹, M. E. McKay¹, M. Taylor², T. Reverter-Gomez³, P. G. Allingham², and R. Seymour³, ¹*Cattle and Beef Quality Cooperative Research Centre, Armidale, Australia*, ²*Australian Sheep Industry Cooperative Research Centre, Armidale, Australia*, ³*CSIRO Livestock Industries, St. Lucia, Australia.*

Connective tissues (endomysium and perimysium) are important contributors to growth and development of the muscle, being the site of capillary invasion, adipogenesis and age maturation. Perimysium is also an important contributor to meat toughness, though its contribution is difficult to quantify due to the inability of extraction techniques to account for three dimensional distribution. Here we describe a morphometric technique for quantification of the amount and frequency of perimysial seams. Longissimus dorsi muscle samples were collected by biopsy or necropsy and then either chemically fixed or frozen for histological sectioning. Muscle fascicular structure (FS) was visualised at low magnification, and morphological features were measured using image analysis tools. The features included perimysial seam width (SW) and average fascicular bundle width (BW). Our data suggest that FS measurements were robust and repeatable, and stable across divergent sarcomere lengths. *Bos indicus* (10 animals) and *Bos taurus* (10) muscles could be differentiated by SW, even though the number of seams per cm of tissue did not differ (42 ± 2.3 , *Bos indicus*; 46 ± 3.8 , *Bos taurus*). Animals came from similar nutritional backgrounds. Although SW values were vastly skewed, the residuals of the fitted mixed-model were normally distributed. *Bos indicus* animals were found to have significantly fewer fine connective tissue seams than did the *Bos taurus* animals (P<0.05). *Bos indicus* also had significantly larger BW than did the *Bos taurus* animals (P<0.05). Apart from the gross phenotypic and enzymic differences between these cattle breed types, there are also finer structural differences that have resulted from the evolutionary divergence of these breeds. Measurements on FS from sheep longissimus dorsi muscle differentiated animals of divergent EBV for muscling (control muscling EBV, SW, 9.7 ± 0.4 ; high muscling EBV, SW, 8.3 ± 0.3 ; P<0.01), when nutrition was comparable. We propose that muscle fascicular structure is a heritable and developmentally regulated phenotype of mammalian skeletal muscle.

Key Words: Meat, Connective Tissue, Tenderness

240 Growth characterization of callipyge myoblasts. J. N. Fleming*, S. P. Jackson, and J. R. Blanton, Jr., *Texas Tech University, Lubbock.*

The objective of this study was to compare the growth rates of isolated myoblasts from both *callipyge* and normal (non-*callipyge*) lambs. *Callipyge* is a mutation found in sheep that causes muscle hypertrophy in the loin and hindquarters of lambs after they reach four to six weeks of age. Myoblasts, or satellite cells, are important factors in postnatal muscle growth, as they are located beneath the basement membrane and contribute to muscle fiber hypertrophy and repair. Lambs ranging from two to eight weeks of age were euthanized and the semimembranosus muscle was excised. Myoblasts were isolated by Pronase[®] digestion and a series of differential centrifugations. Cells were plated on 0.1% gelatinized round culture plates and grown in MEM- α media supplemented with ten percent fetal bovine serum. Plates were incubated at 37°C, 5% CO₂, and media was changed every two days. All plates were counted and replated using trypsin digestion. Primary plates were counted and replated at a level of one million cells per secondary plate. Secondary plates were counted every 24h, 48h, and 72h for all *callipyge* (n=13) and normal (n=19) lambs. Percent gain did not differ across genotypes at 24h (P=0.9361), or 48h (P=0.9739). However, a significant difference was seen at 72h (P=0.0135), with the average gain in *callipyge* plates at $307\% \pm 46\%$ gain, versus the normal rate of $152\% \pm 41\%$ gain. This increase in growth rate could be attributable to either an upregulated mitotic cellular division rate in *callipyge* cells, or perhaps an increased secretion of growth factors from the *callipyge* cells, promoting cell proliferation. In conclusion, there is an increase in *callipyge* myoblast growth rates *in vitro* when compared to normal ovine myoblast growth rates.

Key Words: Sheep, *Callipyge*, Myoblasts

241 Integration of myostatin-null alleles in leptin db/db mice does not alter body composition. A. C. Dilger*, A. L. Grant, M. E. Spurlock, and D. E. Gerrard, *Purdue University, West Lafayette, IN.*

Mutation in the myostatin gene and disruption of the leptin axis in animals leads to excessive accumulation of muscle and fat, respectively. Recent reports indicate that when myostatin and leptin genes are rendered nonfunctional in mice, fat accumulation in leptin obese (ob/ob) mice is suppressed; however, it is unknown whether fat accumulation is decreased when the myostatin and db/db mutations are combined. Therefore, pups from double heterozygous breeding pairs were weaned at 21 d of age and housed individually. Standard mouse chow and water were provided ad libitum. Animals were euthanized at 9 wk of age for body composition analysis. Mice were genotyped as myostatin null (MKO), leptin db/db (LKO), wild type (WT) or myostatin/leptin db/db double knock-out (DKO). At weaning (21d), LKO mice were heaviest (P < 0.05). At 6 wk of age, BW of MKO, DKO, and LKO was 22%, 41%, and 61% heavier (P < 0.05) than WT, respectively. At 9 wk of age, BW of MKO, DKO, and LKO was 26%, 98%, and 51% heavier (P < 0.05) than WT, respectively. A significant time and genotype interaction (P < 0.001) existed for BW. Percent body fat of DKO and LKO was 150%, whereas MKO body fat was 50% of WT (P < 0.001). No differences were observed in percent body fat of DKO and LKO mice. Percent protein of MKO was 10% greater (P < 0.05) whereas LKO and DKO percent protein was 41% less than WT. No differences in percent protein were observed between LKO and DKO mice. Fat mass was 4.62 g greater (29%; P < 0.05) and protein mass was 0.72 g less (13%; P < 0.05) in DKO than in LKO and MKO, respectively. These data show that mice lacking both functional myostatin and leptin axes become as obese as those mice possessing the leptin db/db mutation alone suggesting that the muscle growth potential associated with the loss of myostatin function may not be sufficient to alter body composition.

Key Words: Myostatin, Leptin, Mouse

Nonruminant Nutrition: Weanling Pig Nutrition and Health

242 Potassium source and level influence performance day 21 42 post-weaning. B. V. Lawrence*, J. D. Hahn, and S. A. Hansen, *Hubbard Feeds Inc, Mankato, MN.*

Two trials with terminal cross Duroc sired pigs were conducted to evaluate the influence of potassium (K) source and inclusion level in post-weaning diets. In Exp 1, 1,712 pigs (11.9 ± 0.3 kg) were assigned to either a control diet (0.22% Na, 0.44% Cl, and 0.78% K), or the Control diet supplemented to 0.96% K from KCl (0.23% Na, 0.56% Cl), KHC03 (0.22% Na, 0.33% Cl), or KCl balanced to the same Na and Cl (KCl Low Cl) as the KHC03 treatment (n = 8). Pens were weighed on d-0 and 21. In Exp 2, 950 pigs (13.0 ± 0.9 kg) were fed one of five diets. The control diet from Exp 1 was used and was supplemented with 0.09% or 0.18% K from KCl or KHC03 (n = 8). All diets contained 0.22% Na. Diets were formulated to 0.40, 0.48, 0.56, 0.33, and 0.33% Cl for the control, 0.09 and 0.18% added K from KCl and 0.09 and 0.18% added K from KHC03 respectively. During Exp. 2, pens were weighed on d-0, 14, and 28. In both experiments, Na and Cl levels were manipulated by altering levels of dietary NaCl and NaPO4. Data was analyzed using the GLM procedures of SAS with pen as the experimental unit for gain, intake and feed conversion. In Exp 1, intake was unaffected by treatment (P>0.10). Gain increased in a KCL Low Cl<KHC03<KCl=control manner. Lower gains of the KCl Low Cl fed pigs at similar intakes resulted in a poorer gain to feed compared to the other treatments. During the first 14-d of Exp 2, gain and intake were not statistically different (P>0.10). Gain, however, was numerically higher for the 0.18% added K treatments resulting in an improvement (P<0.001) in gain to feed. From day 14 28, intake was not affected by treatment (P>0.10), however, gain and gain to feed were poorer (P<0.0001) when K level was increased compared with the controls. Gain and gain to feed were significantly lower (P<0.05) for the pigs fed diets with 0.18% added K from KHC03. These results suggest benefit to short-term (<14-d) K supplementation at 21-d post-weaning, however, long-term (> 21-d) K supplementation may be detrimental to gain and gain to feed, particularly if the supplemental K (0.18%) is supplied as KHC03.

Key Words: Potassium, Growth, Pigs

243 Inorganic anions (Animate® concentrate) stimulate growth in nursery pigs fed diets without antibiotics regardless of diet buffering capacity. T. D. Crenshaw*¹ and D. E. Axe², ¹University of Wisconsin, Madison, ²IMC, Lake Forest, IL.

Diets with low buffer capacity (LB) have stimulated growth and altered ingesta microflora of nursery pigs compared with pigs fed diets with high buffer capacity (HB), or sub-therapeutic antibiotics in a herd with chronic salmonella problems. LB diets involved shifts in sources (calcium tribasic phosphate and calcium sulfate) and levels of Ca and P. The current objective was to determine if shifts in cation-anion balance, or the source of inorganic anions altered growth. A complex basal diet was altered to provide HB (0.80 % Ca, 0.80 % P) or LB (0.55 % Ca, 0.65 % P) diets with 3 sources, CaCO₃, CaSO₄, or Animate (a concentrated formulation of Animate for pigs as a source of Cl and SO₄). Antibiotics were not added to any diets. Crossbred (PIC Cambrough X Line 19) pigs (n = 96, 4 pigs per pen) were weaned (3 wk) and randomly allotted to 6 diets for a 32-d trial (P1, 15 d; P2, 17 d). In P2 and the entire trial pigs fed Animate gained more (P < 0.02) than pigs fed CaCO₃ or CaSO₄ regardless of diet buffering capacity. Feed intake increased (P < 0.02) in pigs fed Animate. No differences were observed in feed efficiency. The lack of response to diet buffer capacity is not consistent with earlier results and may be related to lower initial prevalence (< 20 %) of salmonella-positive pigs. Improved growth of pigs fed Animate was likely due to Cl rather than cation-anion balance or buffer capacity. Growth and feed intake responses to inorganic anions

	HB Capacity			LB Capacity			SEM
	CaCO ₃	CaSO ₄	Ani-mate	CaCO ₃	CaSO ₄	Ani-mate	
CAB ^a :	210	189	189	110	89	89	
Cl, %:	0.52	0.52	0.62	0.52	0.52	0.62	
Gain, kg/d							
Period, d							
0-15	0.21	0.20	0.22	0.24	0.21	0.25	0.02
15-32 ^b	0.59	0.58	0.64	0.57	0.58	0.66	0.02
0-32 ^b	0.41	0.40	0.44	0.41	0.41	0.47	0.02
ADFI, kg/d							
0-15	0.30	0.29	0.30	0.31	0.29	0.34	0.02
15-32 ^b	0.84	0.82	0.88	0.82	0.84	0.93	0.03
0-32 ^b	0.59	0.57	0.61	0.58	0.59	0.66	0.02

^aCation-anion balance = (Ca + Na + K + Mg) - (1.8·P + Cl + S) mEq/kg in P2 diets;

^bP < 0.02.

Key Words: Cation-Anion Balance, Chloride, Salmonella

244 Effects of diet acidification and buffering capacity on weanling pig growth. M. Walsh*, D. Sholly, K. Saddoris, R. Hinson, A. Yager, A. Sutton, S. Radcliffe, B. Harmon, and B. Richert, *Purdue University, West Lafayette, IN.*

A study utilizing 192 weanling pigs evaluated the effects of diet acidification and buffering capacity on pig growth. Pigs (19.1 d average age) were assigned to one of three dietary trts: 1) Basal control diet (NC); 2) Diet 1 + 55 ppm carbadox (CB); 3) Dietary acid (DA): diet 1 + .4% organic acid based blend (fumaric, lactate, citric, propionic, and benzoic acids) for d 0-14 followed by .2% inorganic acid based blend (phosphoric, fumaric, lactic, and citric acids) for d 14-28. Each trt was formulated with either limestone or calcium sulfate as a calcium source to change the buffering capacity. Pigs were allotted based on genetics, gender, and initial BW (average of 5.9 kg) and were housed at 6 or 7 pigs/pen. Pen feed intake and individual BW were recorded weekly. Treatments were fed throughout the trial in two phases: d 0-14 and 14-28. During phase 1, pigs fed CB had greater ADG (P<.10) and BW (P<.03) than pigs fed the NC with pigs fed DA being intermediate. During phase 2 and overall, pigs fed CB had greater ADG (P<.01) than pigs fed NC and DA (Overall ADG: 298 vs 252 and 268 g/d, respectively). Pigs fed CB had greater ADFI (P<.04) during phase 2 and overall than pigs fed the NC with pigs fed the DA being intermediate. On d 28, pigs fed CB were heavier than pigs fed NC or DA (14.3 vs 12.9 and 13.4 kg, respectively; P<.001). Overall G:F was greater (P<.06) for pigs fed CB than pigs fed the NC with DA pigs being intermediate. During phase 1, pigs fed diets with limestone as a calcium source tended to have greater ADG (P<.09) than pigs calcium sulfate. During phase 2, pigs fed calcium sulfate had greater G:F (P<.05) than pigs fed limestone. Overall, there was no effect of calcium source on pig growth. In conclusion, pigs fed CB were 1.4 kg heavier and pigs fed DA were 0.5 kg heavier at d 28 post-weaning than the NC pigs. Altering diet buffering capacity had its greatest influence on pig growth during phase 2 when the simplest diet was fed, but did not affect the response to CB or DA.

Key Words: Pigs, Acidification, Buffering Capacity

245 Effects of diet and water acidification on weanling pig growth and microbial shedding. M. Walsh*¹, D. Sholly¹, K. Saddoris¹, R. Hinson¹, A. Sutton¹, S. Radcliffe¹, B. Harmon¹, R. Odgaard², J. Murphy², and B. Richert¹, ¹Purdue University, West Lafayette, IN, ²Kemin Americas, Inc., Des Moines, IA.

This study utilized 205 pigs in a 34 d nursery trial. Pigs (19.2 d of age) were assigned three dietary trts: 1) Basal control diet (NC); 2) Diet 1 + 55 ppm carbadox (CB); 3) Dietary acid (DA); diet 1 + .4% organic acid based blend (fumaric, lactate, citric, propionic, and benzoic acids) for d 0-7 followed by .2% inorganic acid based blend (phosphoric, fumaric, lactic, and citric acids) for d 7-34. These three diets were factored with or without water acidification (WA) of 2.48 mL/L of a propionic acid based blend (KEM SANTM). Pigs were allotted based on genetics, sex, and initial BW (Avg=5.54 kg) with 6 or 7 pigs/pen. Pen FI and individual BW were recorded weekly. Treatments were fed

in three phases: d 0-7, 7-21, 21-34. Feces were collected on d 6, 20 and 33 (3 pigs/pen) for measurement of pH and *E. coli*. No trt effects ($P > .05$) were observed during phase 1. During phase 2, pigs fed CB had greater ADG ($P < .03$) and G:F ($P < .06$) than pigs fed DA and tended ($P < .10$) to have greater ADG than pigs fed NC. During phase 3 and overall, pigs fed CB had greater ($P < .0001$) ADG (overall; 389 vs 348 and 348 g/d, respectively), ADFI and d 34 BW (18.8 vs 17.3 and 17.3 kg, respectively) than pigs fed NC and DA. Phase 3 G:F was greater for pigs fed DA than pigs fed NC ($P < .05$). Phase 3 ADG was improved by WA across all diets ($P < .01$), while WA increased ADFI only in pigs fed CB and NC but not DA ($P < .04$). Pigs receiving no WA had greater overall G:F ($P < .03$) than pigs receiving WA. Feeding CB tended to reduce *E. coli* on d 33 compared with pigs fed DA ($P < .10$). Pigs fed DA tended ($P < .10$) to have lower fecal pH than pigs fed CB on d 20. Pigs receiving WA tended ($P < .10$) to have lower fecal pH than pigs receiving no WA on d 33. In conclusion, pigs fed CB were 1.5 kg heavier at d 34 post-weaning than both NC and DA. The combination of DA with WA resulted in decreased ADFI and overall growth performance, while all other treatment combinations improved pig growth above the NC alone.

Key Words: Pigs, Carbadox, Acidification

246 Effects of diet acidification and antibiotics on weanling pig growth and microbial shedding. M. Walsh*, D. Sholly, K. Saddoris, R. Hinson, A. Yager, A. Sutton, S. Radcliffe, B. Harmon, and B. Richert, *Purdue University, West Lafayette, IN.*

Two hundred ten weanling pigs were used in a 35 d trial to evaluate the effects of a dietary acid and/or antibiotics in nursery pig diets. Pigs (18.3 d of age) were assigned to three dietary trts: 1) Basal control diet (NC); 2) Diet 1 + 55 ppm carbadox (CB); 3) Diet 1 + 38.6 ppm Tiamicin + 441 ppm Chlortetracycline (CTC) d 0-7 followed by 110 ppm CTC d 7-35 (TC). These three trts were factored with or without a diet acidification (DA); .4% organic acid based blend (fumaric, lactate, citric, propionic acid, benzoic acid) for d 0-7 followed by .2% inorganic acid based blend (phosphoric, fumaric, lactic, citric acid) for d 7-35. Pigs were allotted based on genetics, sex, and initial BW (Avg=5.6 kg) with 7 pigs/pen. Pen FI and individual BW was recorded weekly. Three diet phases were fed: d 0-7, 7-21, 21-35. Feces were collected on d 6, 20 and 33 (3 pigs/pen) for measurement of pH and *E. coli*. During phase 1, ADG, ADFI, G:F and d 7 BW for pigs fed CB and TC were greater than pigs fed NC ($P < .04$). During phase 2 pigs fed CB and TC had greater ADG and ADFI and d 21 BW ($P < .01$) than pigs fed NC. During phase 3, CB fed pigs had greater ($P < .06$) ADG and ADFI than NC fed pigs. Overall, pigs fed CB and TC had greater ADG ($P < .004$; 315 and 303 vs 270 g/d respectively), ADFI ($P < .01$) and d 35 BW (16.74 and 16.23 vs 15.08 kg, respectively; $P < .002$) than pigs fed NC. Pigs receiving DA tended to have greater G:F ($P < .09$) than pigs receiving no DA during phases 2 and 3. Overall ADG tended ($P < .07$) to improve with DA and NC or TC diets, but decreased when DA was added to the CB diets. Pigs fed CB shed lower counts of *E. coli* on d 33 compared with pigs fed TC or NC ($P < .0001$). Pigs fed CB and TC tended to have lower fecal pH on d 6 compared to pigs fed NC ($P < .002$). Feeding DA reduced fecal pH on d 6 and *E. coli* shedding on d 33 compared to pigs receiving no DA ($P < .10$). DA tended to increase growth performance above NC and TC diets alone. However, overall growth performance was greatest when CB was fed alone and not with DA.

Key Words: Pigs, Antibiotics, Diet Acidification

247 Use of δ -aminolevulinic acid in swine diet: effects on growth performance, behavioral characteristics and hematological/immune statuses in nursery pigs. R. D. Mateo*, F. Ji, and S. W. Kim, *Texas Tech University, Lubbock.*

Certain amino acids are essential precursors of a variety of important biomolecules in addition to their major function as protein building blocks. δ -aminolevulinic acid (ALA) is synthesized from the condensed form of succinyl-CoA with glycine after decarboxylation catalyzed by δ -aminolevulinic synthase. The objective of the study was to determine effects of ALA supplementation on growth performance, behavioral characteristics and hematological/immune statuses in nursery pigs. A total of 144 pigs weaned at 21 days of age were allotted to 3 dietary treatments representing (-) control (w/o antibiotics), (+) control (w/ Carbadox at 50 mg/kg as pure form or 1% as diluted form), and treatment group with ALA supplementation (0.05%). Each treatment had 6 pens (replicates) with 8 pigs per pen. Pigs were fed Phase 1 (21.86%

CP, 1.4% Lys) and 2 (20.6% CP, 1.15% Lys) experimental diets for 3 and 2 wks, respectively. Feed intake and weight gain were measured weekly during Phase 1 and at the end of Phase 2. At the end of Phase 2, blood samples were taken and analyzed using an automated hematology analyzer. Skin color and activity of pigs (48 hrs) from all pens in each treatment were measured at the second week of Phase 2. Growth performance was not affected ($P > .05$) by the dietary supplementation of ALA during nursery phases. Pigs in the ALA and (+) control groups had a higher ($P < .05$) number of red blood cells than pigs in the (-) control group (6.46, 6.68, and 6.15 $\times 10^6$ cell/ μ L, respectively). Pigs in the (+) control had a higher ($P < .05$) hemoglobin level than pigs in the (-) control and ALA groups (12.16, 11.29, and 11.47, respectively). Pigs in the ALA and (+) control groups had darker ($P < .05$) and less ($P < .05$) yellow skin color than pigs in the (-) control group. Pigs in the (+) control tended to be less active ($P < .10$) than pigs in the other groups. There was no difference in behavioral characteristics between (-) control group and ALA group. The data suggest that ALA improves red blood cell counts which can be beneficial to pigs.

Key Words: Aminolevulinic Acid, Antibiotics, Nursery Pigs

248 The effect of dietary protein on growth performance and fecal consistency of 9 to 24 kg pigs following an enteric challenge with K88 *E. coli*. D. C. Kendall*¹, R. W. Fent¹, S. X. Fu¹, J. L. Usry², J. A. Carroll³, and G. L. Allee¹, ¹University of Missouri, Columbia, ²Ajinimoto Heartland LLC, Chicago, IL, ³ARS-USDA Animal Physiology Research Unit, Columbia, MO.

Two experiments were conducted to determine the effect of dietary protein on growth performance and fecal consistency of 9 to 24 kg pigs following an enteric challenge with K88 *E. coli*. In Exp. 1, 96 barrows (10.2 kg; PIC C-23) were allotted by weight in a randomized complete block design and fed one of four dietary treatments with eight replicates of three pigs per pen. Diets contained 25.5, 23.6, 21.8, and 20.1% CP, achieved by decreasing the level of soybean meal inclusion and increasing crystalline amino acid use while maintaining 1.32% TID Lys. Diets contained no growth promoting antibiotics or copper sulfate. Following a 7d acclimation period, pigs were enterally dosed with 3.95 $\times 10^8$ CFU K88 *E. coli*. Fecal consistency was measured daily with subjective fecal scores (0-3) where 0 = normal, 1 = mild, 2 = moderate, or 3 = severe diarrhea. In addition, fecal samples were collected on d 2, 3, 4, 6, and 8 for moisture determination. From d 2 to 8, fecal scores ($P < .003$) and fecal moisture ($P < .05$) declined linearly with decreasing dietary protein (.65, .45, .27, and .26 units; 74.3, 73.1, 72.6, and 72.3% moisture, respectively). For the 14 d following challenge, there was no effect of dietary treatment on growth performance. In Exp. 2, 188 barrows (9.0 kg; TR-4 X PIC C-22) were allotted by weight in a randomized complete block design and fed one of four dietary treatments with 10 replicates of four or five pigs per pen. Dietary treatments and procedures were the same as Exp. 1. Fecal consistency was measured on a subset of pigs (n = 96) on d 0, 2, 4, 6, 8, 10, 12, and 14. For the first 7 d following challenge, fecal scores ($P < .001$) and fecal DM ($P < .001$) declined linearly with decreasing dietary protein (1.36, 1.07, .86, and .53 units; 80.8, 79.0, 77.4, and 74.5% moisture, respectively). Similar to Exp. 1, dietary treatment did not influence post-challenge growth performance of pigs. These experiments clearly demonstrate that dietary protein negatively influences fecal consistency but does not affect growth performance during an enteric challenge.

Key Words: Pigs, *E. Coli*, Protein

249 The effect of lactose and inulin on intestinal morphology, microbiology and volatile fatty acids of the weanling pig. K. M. Pierce*¹, J. J. Callan¹, P. O. Brophy¹, P. McCarthy², T. Sweeney¹, E. Fitzpatrick¹, C. Byrne¹, S. Ni Cheallaigh¹, and J. V. O'Doherty¹, ¹University College, Dublin University, Dublin, Ireland, ²Volac International Ltd..

Twenty piglets (21 d, 8.0 kg BW) were used in a 2 x 2 factorial to investigate interactions between lactose and inulin on intestinal morphology, microbiology, and VFA production of the weanling pig. The piglets were fed the following diets for 6 d and sacrificed: (T1) 100 g/kg Lactofeed 70 (LF70; 860 g whey permeate and 140 g soy bean meal/kg; Volac International, UK), (T2) 100 g/kg LF70 + 15 g/kg inulin, (T3) 350 g/kg LF70, and (T4) 350 g/kg LF70 + 15 g/kg inulin. Tissue samples were taken from the duodenum (Duo), jejunum (Jej), and ileum for morphological measurements. Digesta samples were taken from the ileum, caecum, and

colon. There was an interaction ($P < 0.001$) between LF70 and inulin in villous height (VH) in the Duo, Jej, and the ileum. In the Duo and ileum, the inclusion of 350 g/kg LF70 increased VH compared to 100 g/kg LF70. However, there was no difference between 100 g/kg and 350 g/kg LF70 when the diets were supplemented with inulin. In the Jej, the inclusion of inulin at 100 g/kg LF70 increased VH compared to 100 g/kg LF70 without inulin. However, inulin had no effect on VH at 350 g/kg LF70. The inclusion of 350 g/kg LF70 increased lactobacilli (+15%) and reduced coliforms (-10%) in the caecum and colon. The inclusion of 350 g/kg increased ($P < 0.05$) total VFA compared to 100 g/kg LF70 (143.0 vs 105.6 mmol/L; SEM, 11.4) in the caecum. There was an interaction ($P < 0.05$) between LF70 and inulin for total VFA concentration in the colon. The pigs receiving 350 g/kg LF70 had a higher total VFA concentration compared to pigs on 100 g/kg LF70. However, there was no difference between 100 g/kg and 350 g/kg LF70 when the diets were supplemented with inulin. In conclusion, high levels of LF70 increased total VFA concentrations and improved gut morphology and gut microflora. Inulin inclusion resulted in improvements in these parameters at the low LF70 level.

Key Words: Pigs, Lactose and Inulin, Intestinal Morphology

250 Effects of lactic acid and lactose on the digestive tract of nursery pigs. M. F. Palacios*, E. A. Flickinger, C. M. Grieshop, C. T. Collier, and J. E. Pettigrew, *University of Illinois, Urbana*.

The objective of this study was to measure the effects of lactose (L) and (or) lactic acid (A), on gastrointestinal tract characteristics of pigs during a 4-wk experiment. A total of 96 pigs were weaned and blocked on the basis of litter. The experiment was carried out as a RCBD, with six blocks, and four diets. The experiment was conducted as a 2 x 2 factorial arrangement of treatments, with factors being L and A. Pigs were fed one the following diets: 1) Basal (B), 2) B + L, 3) B + A, or 4) B + L + A. A 3-phase feeding program was employed for this experiment with phases 1, 2 and 3, corresponding to week 1, week 2, and weeks 3 and 4 respectively. Each of the B diets contained corn starch, which was replaced or not by L and A according to the dietary treatment. The levels of L varied according to the phase: 21% for phase 1, 14% for phase 2, and 7% for phase 3. The A was added to provide 0.75%. Half of the pigs were euthanized for collection of gastrointestinal data, utilizing 24 pigs on each of days 7 and 28. The following characteristics were measured from the tract: wet weight of organs, pH, concentration of lactate, concentration of VFA, bacterial culture of *Lactobacillus* and total anaerobes, quantitative PCR for *Lactobacillus* rDNA and total bacterial rDNA. No differences among treatments were found in wet weight of organs at 7 or 28 days post-weaning. The pH measured in all gastrointestinal segments was reduced ($P=0.01$) at 7 days post-weaning by the incorporation of A. Concentrations of lactate along the tract were not affected by treatment. Concentrations of VFA were altered, most notably reductions in terminal ileum on day 7 and distal colon on day 28 with A. The number of total anaerobes was reduced by A in stomach, terminal ileum contents and mucosa on day 7 ($P=0.01$). Also on day 7, *Lactobacillus* rDNA concentration was reduced ($P=0.02$) when both L and A were added to the diet, and *Lactobacillus* rDNA as a proportion of total bacteria rDNA concentration was reduced ($P=0.01$) when L was added to the diet.

Key Words: Pig, Lactic Acid, pH

251 Effects of lactic acid on growth performance of nursery pigs. M. F. Palacios*, K. T. Soltwedel, G. R. Hollis, and J. E. Pettigrew, *University of Illinois, Urbana*.

A 6-wk experiment was conducted to evaluate the effect of increasing levels of lactic acid (A) to improve growth performance and health status of nursery pigs in a commercial farm. The experiment was carried out as a randomized complete block design with four treatments. Overall, four rooms were used, with 12 blocks, 48 pens, and 1584 pigs. Pigs were weaned at an average of 17.3 d of age and 5.42 kg BW. The feeding program was divided into four phases: Phase 1 (wk 1), Phase 2 (wk 2), Phase 3 (wks 3 and 4), and Phase 4 (wks 5 and 6). Diets contained corn, whey, oat groats, soybean meal, fish meal, blood plasma, and soy protein concentrate; and corn starch, which was replaced or not by a lactic acid product according to the dietary treatment. Pigs were fed one of the following dietary treatments: 1) Basal (B), 2) B+0.75% A (0.75A), 3) B+1.50% A (1.50A), and 4) B+2.25% A (2.25A). During the last two

wks (Phase 4), all pigs received the same basal diet, with no addition of lactic acid to the diet. None of the diets contained antimicrobials. Performance criteria including ADG, ADFI, and G:F were measured for each phase of the experiment. In addition, medical treatments, and pig removals were recorded daily as measures of health status. The experimental treatments did not affect ADG, G:F or health status. Daily feed intake showed a quadratic response ($P=0.04$). The quadratic responses showed the greatest ADFI on the extreme treatments, and lower ADFI on the lower lactic acid inclusions. The results for this experiment did not show clear responses to increasing levels of lactic acid.

Diet	B	0.75A	1.50A	2.25A	SEM	Linear	Quadratic
						P-value	P-value
ADG, g	366	355	367	365	4	0.61	0.37
ADFI, g	526	515	516	529	6	0.77	0.04
G:F	707	691	713	706	9	0.64	0.61
Removals, %	3.78	2.78	1.25	2.28	1.05	0.21	0.34
Treatments, %	1.35	1.44	1.40	1.58	0.13	0.37	0.66

Key Words: Pig, Lactic acid, Performance

252 Comparison of the effect of direct-fed microbials and antibiotic supplementation on the growth response of weanling pigs. M. S. Dirain*¹, M. E. Davis¹, D. C. Brown¹, C. V. Maxwell¹, Z. B. Johnson¹, and T. Rehberger², ¹University of Arkansas, Fayetteville, ²Agtech Products Inc., Waukesha, WI.

Pigs (n=252) from 30 litters were used to compare the effect of direct-fed microbials and antibiotic supplementation on the growth of nursery pigs. Beginning at farrowing, pigs were provided milk supplementation with or without the addition of *Lactobacillus brevis* (1E-1) via an in-line system. These treatments were continued during the nursery period, in which pigs that were administered 1E-1 via milk supplementation continued to receive 1E-1 through the watering system. At the start of the nursery phase, pigs were fed a basal diet, the basal diet with *Bacillus* cultures, or the basal diet with antibiotics. These dietary treatments were administered during Phase 1 (d 0 to 14 after weaning), Phase 2 (d 14 to 28), and Phase 3 (d 28 to 38), in a 2 x 3 factorial design during the nursery period. Data were analyzed using the GLM procedure of SAS, and the effects of 1E-1 supplementation, dietary treatments, and their interaction were evaluated. No interaction was observed between 1E-1 supplementation and the dietary treatments ($P > 0.15$). Pigs supplemented with 1E-1 had greater ADG ($P < 0.05$) during Phase 2 and the overall nursery period (d 0 to 38), greater ADFI ($P < 0.05$) during Phase 3 and the overall nursery period, and tended to have improved gain:feed ($P < 0.10$) during Phase 3. Pigs supplemented with antibiotics during the nursery had greater ($P < 0.01$) ADG during Phase 2 and the overall nursery period, and greater ($P < 0.01$) ADFI during Phase 3 than pigs fed the basal diet or pigs fed *Bacillus*. Although pigs supplemented with antibiotics had greater ($P < 0.05$) gain:feed than pigs fed *Bacillus* during Phase 2, pigs fed *Bacillus* had greater ($P < 0.01$) gain:feed during Phase 3 than pigs fed the basal diet or those fed antibiotics. Pigs fed antibiotics during the nursery were 2 kg heavier at the end of the nursery than pigs fed the basal diet or *Bacillus*, whereas 1E-1 supplementation resulted in a 1.5 kg improvement ($P < 0.01$) in body weight at the end of the nursery period compared to pigs not receiving 1E-1. This study indicates that 1E-1 supplementation during lactation and the nursery phase improves the growth response of pigs during the nursery period.

Key Words: Swine, *Lactobacillus*, Feed Supplements

253 Efficacy of mannan oligosaccharides supplementation of both sows and piglet diets on the performance of weaned piglets. M. I. Gracia*¹, J. Morales², J. Pickard³, J. Sánchez¹, and F. Baucells¹, ¹Imasde Agropecuaria, S.L. Spain, ²PigChamp Pro Europa Spain, ³Alltech Inc., Ireland.

A trial was conducted to study the effect of supplementing piglet diets with a source of mannan oligosaccharides (MOS, Bio-Mos[®]) on performance of weaned piglets from weaning at 28 d to 60 d of age. Five hundred and thirty two crossbred piglets (Large White x Large White*Landrace), half male and half female, were allocated randomly to 28 replicates of 19 piglets each. A completely randomized block (room) design was applied using four experimental treatments arranged as a 2

× 2 factorial with main effects of piglet origin: 1) control sows, and 2) sows receiving 1 g/kg of MOS during lactation, and dietary treatment: 1) basal diet (control), and 2) basal diet with MOS at 2 g/kg in prestarter and 1 g/kg in starter diets. The experimental design was applied in both the prestarter (28 to 44 d of age) and the starter (44 to 60 d of age) periods. Nutritive value of the diets was 2.5 Mcal NE/kg and 14.8 g/kg lysine for prestarter, and 2.5 Mcal NE/kg and 13.3 g/kg lysine for starter, and were based on barley, corn, and wheat. Data were analyzed as a completely randomized block design with piglet origin and dietary treatment as main effects and weaning weight as a covariate. For the overall period (28 to 60 d of age), piglets coming from sows eating MOS during their lactation period grew more than piglets from control sows independently from their dietary treatment after weaning (339 vs 363 g/d; $P < 0.05$). On the other hand, piglets supplemented with MOS tended to have better feed conversion ratio than control piglets independently from their origin (1.50 vs 1.39 g feed/g gain; $P = 0.059$). No interactions were detected between main effects for any of the parameters studied. It was concluded that: i) the supplementation of lactation diets with MOS improved growth of piglets during the post-weaning period with independence of dietary treatment within this period, and ii) addition of MOS to post-weaning piglet diets improved feed efficiency.

Key Words: Mannan Oligosaccharides, Lactation, Piglets

254 Impact of spray-dried plasma with or without antimicrobials on nursery pig performance. P. Srichana^{*1}, A. M. Gaines¹, B. W. Ratliff¹, G. L. Allee¹, J. D. Crenshaw², J. M. Campbell², J. D. Quigley², and L. E. Russell², ¹University of Missouri, Columbia, ²APC Inc., Ankeny, IA.

An experiment was conducted at a commercial research site to evaluate the impact of spray-dried plasma (SDP) with or without antimicrobials (AM) on nursery pig performance. A total of 792 pigs (TR-4 × C22; 5.66 ± 0.05 kg) were used in a completely randomized block design with 6 replicate pens/treatment and 22 pigs/pen. Growth performance was evaluated during four dietary phases: Phase 1 (d 0-7), Phase 2 (d 7-14), Phase 3 (d 14-28) and Phase 4 (d 28-50). Diets were formulated to contain 1.60% and 1.50% total lysine in phase 1 and 2, respectively and 1.42% and 1.32% true digestible lysine in phase 3 and 4, respectively. Treatments were as follows: 1) 0% SDP without AM (d 0-50); 2) 0% SDP with AM (d 0-50); 3) SDP (6% Phase 1, 3% Phase 2, 1.5% Phase 3, 0.75% Phase 4) without AM; 4) same as treatment 3 with AM; 5) SDP (6% Phase 1, 3% Phase 2); 6) same as treatment 5 with AM. For diets containing AM, the Phase 1 and 2 diets contained 3000 ppm ZnO and 55 ppm Mecadox, while Phase 3 and 4 diets contained 27.5 ppm Mecadox and 100 ppm CuSO₄. In Phase 1, pigs fed SDP and (or) AM had improved ADG ($P < 0.05$) as compared to pigs not fed SDP. Improvements in ADG were due to improvements in ADFI ($P < 0.05$). In Phase 2 and 3, pigs fed AM had improved ($P < 0.05$) ADG, which

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256 The use of statistical process control capability indices to estimate subclinical mastitis prevalence and new infection rates. J. Lukas^{*1}, M. L. Kinsel², and J. K. Reneau¹, ¹University of Minnesota, St. Paul, ²Agricultural Information Management, Ellensburg, WA.

The objective of this study was to calculate a capability index (Cpk) measuring the capability of a herd to meet a desired SCC standard based on the BTSCC (bulk tank somatic cell count) and determine its correlation with subclinical mastitis prevalence (SM) and new infection rate (NIR) estimates. BTSCC data collected daily or every other day for 12 months (January until December 2003) from 694 Minnesota dairies were used to compute the linear score. The mean of individual values, and the average moving range was used to calculate four different Cpk indexes (Cpk400, Cpk500, Cpk600, Cpk750 based on the 400000, 500000, 600000, 750000 SCC standards, respectively) for each of the herds. The SM and NIR values of 272 herds on the Minnesota DHI program were transformed by natural log, merged by farm name with the Cpk indexes and used to examine the relationship between the calculated Cpk indexes and SM and NIR (dataset three, n=269). One hundred eighty herds from dataset three were randomly selected, linear regression models were developed and validated by taking the SM and NIR values observed for the remaining 89 herds and regressing them against the SME (estimated subclinical mastitis values) and NIRE (estimated new infec-

tion rates) calculated from the four linear regression models that were developed. High R² values (0.70, 0.64, 0.58, 0.49 for SM vs Cpk400, Cpk500, Cpk600, Cpk750, respectively) indicated a strong correlation between the BTSCC and herds SM. According to models developed, SM in herds that are able to meet the SCC standard (Cpk ≥ 1), is less or equal to 26%, 30%, 34%, 38% for the 400000, 500000, 600000 and 750000 standard, respectively. The relatively low correlations between NIR and Cpk indexes (R²=0.34, 0.31, 0.28, 0.24 for NIR vs Cpk400, Cpk500, Cpk600 and Cpk750, respectively) indicate that the single DHI test day estimate of NIR was insufficient to accurately describe NIR dynamics.

Key Words: Spray-Dried Plasma, Antimicrobial, Pigs

255 Effect of flaxseed fractions and sub-therapeutic antibiotic inclusion on microbial ecology in small intestine of growing pigs. L. F. Smith^{*1}, R. T. Zijlstra², M. D. Drew¹, and A. G. Van Kessel¹, ¹Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, ²Prairie Swine Centre Inc., Saskatoon, SK, Canada.

Increasing pressure to discontinue the feeding of growth-promoting antibiotics has prompted examination of novel feed ingredients and their effect on intestinal microbial ecology. The impact of antibiotic inclusion, flaxseed, or flaxseed fractions on small intestinal microbial profiles was investigated in growing pigs. Eighteen ileal-cannulated barrows (33.1±2.4 kg) were fed one of six diets (A, basal diet with wheat, peas and soybean meal, 3.40 Mcal/kg DE and 2.65 g dig. lysine/Mcal DE; B, basal diet plus 20% ground flaxseed; C, basal diet plus 18% ground hot-water extracted flaxseed; D, basal diet plus 4% ground flaxseed hulls; E, basal diet plus 8% flaxseed oil; F, basal diet plus 22 mg/kg tylosin phosphate) during each of three 18-d periods in a change-over design for a total of nine observations per treatment. Experimental periods included 16 d for diet acclimatization and ileal contents were collected on d 17 and 18. Diets were provided in a wet mash form at 2.8 x maintenance. Approximately 100 ml of ileal digesta was collected in plastic bags containing N₂ following the AM-feeding. Serial dilutions were prepared in sterile peptone and plated on selective media for enumeration of total aerobes and anaerobes, *Clostridium perfringens*, *Lactobacillus* spp., *Bifidobacterium* spp., *Streptococcus* spp., and Enterobacteria. Data were analyzed using the repeated measures procedure in SPSS. *Lactobacillus* spp. plate counts were 7.97, 8.13, 8.52, 7.95, 8.41, and 8.40 log cfu/g for diets A through F respectively, and were increased ($P \# 88040.05$) by flaxseed hulls, oil, and tylosin. Diet composition did not affect plate counts for any other growth media employed. Inclusion of tylosin increased the number of lactobacilli in pig ileum contents as reported by others. Flaxseed fractions also affected ileal bacterial colonization; however, precise identification of compositional changes will require molecular based analyses.

Key Words: Flaxseed, Antibiotic, Pigs

tion rates) calculated from the four linear regression models that were developed. High R² values (0.70, 0.64, 0.58, 0.49 for SM vs Cpk400, Cpk500, Cpk600, Cpk750, respectively) indicated a strong correlation between the BTSCC and herds SM. According to models developed, SM in herds that are able to meet the SCC standard (Cpk ≥ 1), is less or equal to 26%, 30%, 34%, 38% for the 400000, 500000, 600000 and 750000 standard, respectively. The relatively low correlations between NIR and Cpk indexes (R²=0.34, 0.31, 0.28, 0.24 for NIR vs Cpk400, Cpk500, Cpk600 and Cpk750, respectively) indicate that the single DHI test day estimate of NIR was insufficient to accurately describe NIR dynamics.

Key Words: BTSCC, Subclinical Mastitis Prevalence, Statistical Process Control

257 Evaluation of the DHI hot list as a tool to reduce bulk tank somatic cell counts. J. E. Belsito^{*}, A. de Vries, and R. P. Natzke, University of Florida, Gainesville.

Many dairy producers in the Southeast find it difficult to keep their bulk tank somatic cell count (SCC) below the legal limit (750,000 cells/ml) throughout long periods of hot weather. DHI has developed a hot list to assist farmers in identifying high SCC cows in the herd. The hot list identifies the 20 cows that are the greatest contributors of SCC to the

bulk tank on the test day. This list was developed to assist producers in making decisions to cull, treat, withhold milk, or early dry-off to reduce the bulk tank SCC. The objective of this study was to determine the repeatability of cows on the DHI hot list from test day to test day and draw conclusions about its value for the dairy producer. DHI records that have been collected from 1989 (300 cows) to 2001 (500 cows) from one farm tested monthly were analyzed. The herd manager never used the SCC data to make management decisions. The 20 cows on the hot list accounted on average for 46.4% of the cells in the bulk tank (SD 7.7%). Cows on their first test day after calving had a 6.6% (SD 5.7%) chance of being on the list. Second test day cows had an 8.1% (SD 6.2%) chance of being on the hot list while third test day cows had a 7.6% (SD 6.4%) chance. Of the cows that were on the hot list in any given month, 27% (SD 12%) were on the list the following month, 60% (SD 13%) were tested but dropped off the list and 14% (SD 10%) had missing data (not tested). Cows that were not on the hot list had only a 3% (SD 1%) chance of being on the list the following month, 81% (SD 7%) were tested and stayed off the list and 16% (SD 7%) had missing data. If culling decisions were based on the hot list we would expect to observe a higher percentage of cows on the hot list with missing data the following month. We concluded that cows on the hot list did not persistently have the highest SCC in subsequent months. These results indicated that refinement is needed to make the hot list a more valuable tool for the dairy producer.

Key Words: Somatic Cell Count, Hot List, Repeatability

258 Evaluation of the Association between Bulk Tank Somatic Cell Count and Management Practices on U.S. Dairy Operations; Results from the NAHMS Dairy 2002 study. J. E. Lombard^{1,2}, R. P. Dinsmore², J. R. Wenz^{*2}, and C. Tapp², ¹USDA:APHIS:VS; Centers for Epidemiology and Animal Health, Fort Collins, CO, ²Integrated Livestock Management, Colorado State University, Fort Collins.

The National Animal Health Monitoring Systems Dairy 2002 study surveyed dairy operations in 21 states representing 82.8% of U.S. dairy operations and 85.5% of U.S. dairy cows. Producers completed two separate interviews between December 2001 and July 2002. Producers were asked to estimate their mean bulk tank somatic cell count (BTSCC) for the three months prior to the second interview. Responses from 916 operations were represented in the analysis. Variables from both interviews having a priori potential for an association with BTSCC were identified and examined by chi-square testing (SAS, PROC FREQ). Variables with $p < 0.2$ were used to construct two logistic models using 200,000 and 400,000 BTSCC as cut-offs between groups (SUDAAN, PROC LOGIST). Significant variables (p value of Wald F statistic < 0.10) were retained. Percentage of operations reporting $< 200,000$; 200-400,000; or $> 400,000$ BTSCC was 24, 62 and 16 percent, respectively. Operations in the Southeast region of the U.S. were significantly more likely to have higher BTSCC compared to other regions. Higher rolling herd average milk production, having a closed herd and use of shredded newspaper as bedding were associated with lower BTSCC in both models. Milking procedures typically associated with decreased risk of mastitis such as teat disinfection were not retained in either model, except for forestripping prior to milking which was associated with higher BTSCC compared to operations that didn't forestrip any cows. These results of producer reported data suggest our understanding of the association between management practices and BTSCC may be incomplete.

Key Words: Milk, SCC, Management

259 Comparison of paired milk and serum ELISA for diagnosis of Johnes disease in dairy cattle. J. E. Lombard^{*1,2}, T. Byrem³, and B. J. McCluskey¹, ¹USDA:APHIS:VS, Centers for Epidemiology and Animal Health, Fort Collins, CO, ²Integrated Livestock Management, Colorado State University, Fort Collins, ³Antel Biosystems, Inc., Lansing, MI.

Paired milk and serum samples from 35 dairy herds in 17 states were evaluated for cow level and herd level test agreement. Evaluation of 6,349 paired samples suggested moderate cow level agreement between the milk and serum ELISA with a calculated kappa value of 0.50. At both the cow and herd level, the milk ELISA performed equivalent to the serum ELISA using conventional, radiometric and non-radiometric culture methods as a reference for Johnes disease. Cow level sensitivity (Se) and specificity (Sp) on 21 dairy operations with 2,173 animals were

evaluated. The relative cow level Se and Sp of the milk ELISA was 21.2 percent and 98.6 percent, respectively. Cow level relative Se and Sp of the serum ELISA was 23.5 percent and 98.1 percent, respectively. Logistic regression models revealed no association between parity and testing ELISA positive. Milk ELISA tests were more likely to be positive in the first 2 weeks of lactation and then after week 28 of lactation, while cows greater than 45 weeks in lactation were most likely to test positive with the serum ELISA. Milk production at or above herd average was negatively associated with testing ELISA positive. Substantial agreement between ELISA methods at the herd level was found with kappa values greater than 0.6 for comparisons using 1 animal testing positive or greater than 2 percent ELISA prevalence to consider a herd infected. With fecal culture as the reference, point estimates for herd-level Se and Sp for the milk ELISA ranged from 55-83 percent and 67-100 percent, respectively, depending on the ELISA prevalence cutoff. Serum ELISA estimates were similar with Se ranging from 61-83 percent but Sp remained at 33 percent for both prevalence cutoff values. The milk ELISA performed similar to the serum ELISA and has the advantage of decreased labor costs on farms that use DHIA milk testing services.

Key Words: Johnes, Milk ELISA, Diagnostics

260 Financial costs of Johnes disease on U. S. dairy operations. J. E. Lombard^{*1,2}, B. J. McCluskey¹, S. L. Ott¹, and F. B. Garry², ¹USDA:APHIS:VS; Centers for Epidemiology and Animal Health, Fort Collins, CO, ²Integrated Livestock Management, Colorado State University, Fort Collins.

Dairy production records from 38 herds in 16 states were evaluated for mature equivalent (ME) 305 day milk, fat and protein production, ME maximum milk, lactation number, days in milk, days open, and average lactation linear score to determine current lactation marginal costs associated with serum ELISA test status for Johnes disease (JD). A mixed effects model was used to account for herd level clustering with production parameters as dependent variables. Significant production losses associated with JD in dairy cattle included decreased milk production in those animals that tested strong positive by serum ELISA, decreased pounds of milk fat production in those animals that tested strong positive and decreased days in milk for the inconclusive and strong positive compared to the negative and positive test group. Lactation milk production was approximately 6000 pounds less for cows that tested strong positive compared to test negative cows, resulting in a \$720 decrease in potential gross milk revenue. Information on animal removal from herds was evaluated using logistic regression models. Relative herd milk production, lactation number, body condition score and serum result were covariates in the models. Prior to producer knowledge of test outcome, cattle with elevated antibody levels were not at a significantly increased risk of being removed from the herd after accounting for relative herd milk production. Cattle with strong positive and positive test results were at a significantly increased risk of removal, even after adjusting for relative herd milk production once results were released to herd owners. Based on the results of this financial study, cattle that test strong positive on a serum ELISA test for JD should be considered for removal from the herd.

Key Words: Johnes, Dairy, Economics

261 Financial drivers of profitability in dairy businesses. B. J. Hilty^{*}, L. A. Holden, and J. Hyde, Pennsylvania State University, University Park.

Return on assets (ROA) is an important indicator of dairy farm profitability. Although profitability is affected by many factors, ROA is driven by two financial characteristics, financial efficiency and capital efficiency. The operating expense ratio (OER) and asset turnover ratio (ATR) are primary indicators of financial and capital efficiency, respectively. The objective of this study was to identify the primary drivers of profitability of dairy businesses. Financial data from 1998 to 2001 was collected from 46 Pennsylvania dairies through personal interviews. The dairies were nominated for the study by industry professionals. Average herd size of these dairies ranged from 241 cows in 1998 to 273 cows in 2001. Average annual milk production ranged from 20,442 pounds per cow in 1998 to 21,236 pounds per cow in 2001. Average ROA was summarized by herd size and quartile rankings for each year of the study. High profit (HP) dairies were defined as those dairies generating an ROA of 8.0 percent or higher in the year being examined. Although dairies of all sizes were in the HP group, herds greater than 400 cows consistently

generated ROAs greater than 8 percent. High profit herds were classified as capital efficient, financially efficient or a combination of each to varying degrees, with a management matrix. Three of twenty-one HP dairies in 1998 were capital efficient (ATR >.70), while seven were financially efficient (OER < 60%). In 2000, a year of lower milk prices, there were only twelve HP dairies. Of the twelve, two were capital efficient (ATR >.70) and two were financially efficient (OER < 60%). The remaining dairies in both years relied on a combination of capital efficiency and financial efficiency to operate at high profit levels. Several factors that impact financial efficiency, including milk production per cow, feed expense and labor expense, were also examined by profitability group. The HP dairies performed better, numerically, in each area than dairies in the low quartile ranking. High profitability in this non-random farm sample was achieved through various strategies.

Key Words: Dairy, Profitability, Management

262 Economic and environmental feasibility of a continuous four-year lactation model. D. L. Zartman^{*1}, C. A. Rotz², and K. L. Crandall³, ¹Ohio State University, Columbus, ²USDA-ARS, University Park, PA, ³DHI Computing Services, Inc., Provo, UT.

More competitive dairy production systems are needed to improve the sustainability of our dairy industry. To test a perennial lactation concept, a set of 4,259 DHI records demonstrates that about 1% of dairy cows have produced over 20 kg/day for more than four years of continuous lactation. A dairy farm simulation model was used to evaluate the long-term performance, environmental impact, and economics of a conceptual typical dairy farm in Pennsylvania converted to a perennial system. In this system, cows lactated continuously for 4-yrs. Compared to a traditional 100-cow dairy farm with replacement heifers produced on the farm, use of 120 perennial cows with purchased replacements reduced supplemental protein feed purchases 11%, increased annual milk sales 20%, reduced manure production 17%, reduced soil N leaching loss 25%, and increased annual net return to farm management by \$14,200 while maintaining a long-term phosphorus balance for the farm. Compared to a traditional 125-cow dairy farm where replacement heifers were purchased, use of 120 perennial cows with purchased replacements reduced supplemental protein feed purchases 12%, reduced annual milk sales 4%, reduced manure production 7%, reduced N leaching loss 7%, and increased the annual net return to farm management by \$1,600. The economic feasibility of the perennial cow dairy farm was relatively insensitive to assumptions for herd replacement rate and cow mortality, moderately sensitive to milk and heifer prices, and very sensitive to the milk production maintained by the perennial herd. Thus, a perennial cow system can improve the economic and environmental sustainability of traditional dairy production if a similar level in annual milk production per cow can be maintained.

Key Words: Perennial, Lactation, Long-Term

263 Tracing pigs by using conventional and electronic identification devices. D. Babot^{1,2}, M. Hernández-Jover^{*3}, G. Caja³, C. Santamarina², and J. J. Ghirardi³, ¹Area de Producció Animal, Centre UdL-IRTA Lleida, Spain, ²Departament de Producció Animal, UdL, Lleida, Spain, ³Universitat Autònoma de Barcelona, Bellaterra, Spain.

With aim of evaluating the traceability achieved by different identification systems from birth to slaughter, a total of 1,032 pigs were used. Devices were: 1) plastic button ear tags (PET, n = 352); 2) half-duplex (EEH, n = 333) and full-duplex B (EEF, n = 347) electronic button ear tags; and, 3) half-duplex (IPH, 32 mm, n = 340) and full-duplex B (IPF, 34 mm, n = 335) intraperitoneally injected glass encapsulated transponders. Piglets were randomly assigned to treatments and reared under intensive conditions during suckling, growing and fattening periods and harvested in a commercial slaughterhouse. Readability of electronic devices was recorded during the farm period and throughout the harvesting process with full-ISO handheld transceivers. No negative effects or animal health alterations were reported after the identification.

No differences (P > 0.05) in losses between devices were observed during fattening (PET, 2.7%; EEH, 3.8%; EEF, 3.8%; IPH, 1.3%; and, IPF, 2.1%), and no electronic failures were recorded except for the EEF (0.7%). Losses obtained during the harvesting process were greater (P < 0.05) for the EEF (5.7%) than the EEH (4.4%) and PET (1.7%), the two last not differing. Electronic failures during harvesting averaged 1.5% for both electronic ear tags. Intraperitoneal transponders were not affected by the harvesting process and 97.1% were recovered at evisceration. The rest (2.9%) were lost on the slaughterhouse ground and no transponders were found in carcasses. Intraperitoneal transponders showed the greatest traceability values (IPH, 98.7%; and, IPF, 97.9%), the last not differing from conventional ear tags (PET, 95.7%). The lowest traceability values were obtained with electronic ear tags (EEH, 90.6%; and, EEF, 88.6%). In conclusion, the intraperitoneal injection seems to be an efficient system for the identification and traceability of pigs in the food chain.

Key Words: Transponders, Traceability, Swine

264 Initial and terminal implant strategy for heavy weaned Canadian calves. K. S. Eng^{*1}, R. Bectel², and D. P. Hutcheson³, ¹Eng, Inc. San Antonio, TX, ²Advance Agricultural Testing, Baden, ON, Canada, ³Animal-Agricultural Consulting, Inc., Amarillo, TX.

With recent implant clearances, a broad range of implant types of Estrogen (E) only or Estrogen-Tremblone Acetate (ETA) combinations and dose rates are available. This trial was designed to evaluate four different initial implants followed by two combination terminal implants. Experimental animals were approximately 400 head of heavy weaned steer calves weighting approximately 300 kg from Saskatchewan Canada. They were allotted at random at the beginning of the trial to pens of 8 head each and there were 6-12 reps per initial implant treatment. During the initial phase, the cattle fed were fed an intermediate energy ration consisting of silage, wet corn gluten, steamflaked corn and premix. The initial phase was terminated at 91 days, the cattle check weighed and re-implanted with a terminal combination implant of either Synovex Choice or Synovex Plus. During the final 112 day feeding period the cattle were fed a high energy ration consisting of the same ingredients and there were 15 pen reps (8 head) in each implant treatment. The performance results are shown in Table 1. During the initial implant period, cattle receiving Synovex Choice gained more rapidly and tended to converted more efficiently. Calves receiving Synovex C consumed less feed, but had similar conversions. During the final implant phase, cattle receiving Synovex Plus compared to Synovex Choice gained faster and converted more efficiently. Carcass data was not obtained because problems associated with the occurrence of BSE, made it impossible to harvest of the cattle in a timely fashion.

Grow Phase Implant

	Synovex C	Synovex S	Revalor S	Synovex Choice	Prob- ability
Day 0 BW, kg	297.1	304.4	318.0	320.7	NS
Day 91, kg	440.4	450.5	455.4	473.0	NS
ADG kg/day	1.57 ^{ab}	1.61 ^{ab}	1.51 ^b	1.67 ^a	0.015
DMI kg/d	10.1 ^a	10.5 ^{ab}	10.5 ^{ab}	10.8 ^b	0.115
Feed to Gain	6.43 ^{ab}	6.55 ^{ab}	6.97 ^b	6.42 ^a	0.135

Finish Phase Implant

	Synovex Plus	Synovex Choice	
Day 91 BW, kg	460.9 ^a	456.4 ^b	0.09
Day 203 BW,kg	655.9 ^a	630 ^b	0.05
ADG kg/d	1.67 ^a	1.66 ^b	0.05
DMI kg/d	10.7	10.6	NS
Feed to Gain	6.38 ^a	6.65 ^b	0.11

Key Words: Implant, TBA, Estrogen

PSA-Environment and Management-Breeder and Incubation

265 Heavy tom strains fed low calcium and phosphorus diets supplemented with phytase 1. Growth performance and carcass yield. R. M. Hulet*, P. H. Patterson, and T. L. Cravener, *Department of Poultry Science, The Pennsylvania State University, University Park.*

Nicholas, BUTA-B6 and BUTA-T2 strains (A, B, and C) were reared in a total of 24 floor pens (0.309m²/bird) and fed commercial diets until 19 wk of age. The basal feeding program (calculated analysis) included a pre-starter (0-3 wk; 28.3% CP; 1.51% Ca; 1.04% tP), starter (3-6 wk; 27.8% CP; 1.50% Ca; 1.03% tP), grower-I (6-9 wk; 24.5% CP; 1.48% Ca; 1.00% tP), grower-II (9-11 wk; 22.5% CP; 1.39% Ca; 0.92% tP), finisher-I (11-14 wk; 18.9% CP; 1.15% Ca; 0.72% tP), and finisher-II (14-19 wk; 17.4% CP; 1.04% Ca; 0.64% tP). From 11-14 wk half the birds were fed a diet 15% lower in Ca and P (LCP) compared to the control birds (CON). From 14 - 19 wk half the birds were fed a diet 30% lower in Ca and P (LCP) compared to the CON birds. Both diets were supplemented with 0.06 % phytase from 11- 14 and 14 - 19 wk. Dietary treatment did not affect feed intake (FI), feed conversion (FC), 19 wk body weight (BW) or overall mortality. BW at 14 wks and overall BW gain (BWG) were significantly greater for birds fed CON diets. Dietary treatment did not affect processing weight (wt) or wt as a percent of the bled carcass wt. However, LCP diets did result in significant feed savings on a /kgcarcass(CON, .431 versus LCP, .419)and/kg breast basis (Con, 1.857versusLCP,1.749). BW at hatch and wk 3, 6, 9, 11, 14, and 19 were significantly affected by strain, with the C strain males having greater BWG than males from strain A or B. Cumulative FI was significantly different, with the C strain birds consuming more feed than birds from either strain A or B. Overall FC and mortality were not affected by strain. Processing wt was significantly affected by strain, with the wt of the carcass, neck, wing, and breast being greater for C strain carcasses. No difference in processing yield (% of carcass wt) was found for strain. The results suggest that diets 15 and 30% lower in Ca and total P, supplemented with phytase, resulted in similar growth performance and carcass yield and were cost efficient in comparison to CON fed birds. Strain C males were significantly heavier than strain A and B males for much of the study.

Key Words: Turkey, Phosphorus, Strain

266 Heavy tom strains fed low calcium and phosphorus diets supplemented with phytase 2. Impact on litter total P, soluble P and bone integrity. P. H. Patterson*¹, R. M. Hulet¹, T. L. Cravener¹, P. Y. Hester², P. J. Kleinman³, and A. N. Sharpley³, ¹*Department of Poultry Science, The Pennsylvania State University, University Park,* ²*Department of Animal Sciences, Purdue University, West Lafayette, IN,* ³*USDA-ARS, University Park, PA.*

Nicholas, BUTA-B6 and BUTA-T2 strains were reared in a total of 24 floor pens (0.309m²/bird) and fed commercial diets until 19 wk of age. The basal feeding program (calculated analysis) included a pre-starter (0-3 wk; 28.3% CP; 1.51% Ca; 1.04% tP), starter (3-6 wk; 27.8% CP; 1.50% Ca; 1.03% tP), grower-I (6-9 wk; 24.5% CP; 1.48% Ca; 1.00% tP), grower-II (9-11 wk; 22.5% CP; 1.39% Ca; 0.92% tP), finisher-I (11-14 wk; 18.9% CP; 1.15% Ca; 0.72% tP), and finisher-II (14-19 wk; 17.4% CP; 1.04% Ca; 0.64% tP). From 11-14 wk half the birds were fed a diet 15% lower in Ca and P (LCP) compared to the control birds (CON). From 14-19 wk the LCP birds were fed a diet 30% lower in Ca and P compared to the CON birds. Both diets were supplemented with 0.06% phytase from 11-14 and 14-19 wk. Litter water extractable P (WEP) increased during the study from 0.30, 0.48, 2.33, 3.22, 3.66 and 6.04g/kg of litter, respectively, at 3, 6, 9, 11, 14, and 19 wk. From 3 to 19 wk litter total P (TP) and Ca levels increased 2-fold, however, litter WEP was 20-fold greater at 19 wk. Litter WEP from LCP, CON treatments was 3.18, 4.04g/kg (P = 0.2060) at 14 wk and 5.84, 6.25g/kg (P = 0.2863) at 19 wk, respectively. Humerus bone mineral density (BMD) for LCP, CON birds was 0.368, 0.336 g/cm² at 14 wk (P = 0.0617) and 0.371, 0.371 g/cm² at 19 wk. Femur BMD for LCP, CON birds was 0.324, 0.317 g/cm² at 14 wk (P = 0.3844) and 0.372, 0.378 g/cm² at 19 wk (P = 0.6053). There was no difference in litter WEP, TP or Ca levels or humerus or femur BMD between tom strains (P > 0.05). Dietary P levels and costs were reduced by the LCP treatments compared to CON. Litter TP and WEP were reduced 5.8 and 6.6% in the LCP pens

compared to CON at the end of the study. No adverse effect of the LCP diets was observed on tom live performance or bone integrity.

Key Words: Turkey, Litter, Phosphorus

267 Examining if the hole created by egg injection improves late embryonic survival. B. L. Kumpula* and G. M. Fasenko, *Department of AFNS, University of Alberta, Edmonton, AB, Canada.*

The objective of this study was to determine if the hole produced by egg injection at 18 days of incubation has an effect on egg shell conductance and late incubation embryonic mortality. Broiler hatching eggs (n=864) from a Ross 308 flock at two ages (Trial 1 34 wk and Trial 2 42 wk) were incubated in a single stage incubator. At 7 and 14 days of incubation, all eggs were candled, eggs with non-viable embryos removed and broken open to assess fertility, and if fertile, approximate day of embryonic death. At transfer (18 d) half the eggs (Hole - n=432) had a hole made in the shell at the large end of the egg using an 18-gauge needle to simulate egg injection. The needle was inserted to a maximum depth of 2 mm. No injectables were deposited through the needle into the egg. The other half of the eggs (No Hole) were transferred without a hole being made. Twenty-four groups of 18 eggs represented the experimental unit. At 21 d (Trial 1) and 21.5 d (Trial 2) all saleable chicks were counted and any unhatched eggs opened so that hatchability production parameters could be calculated. Concurrently with the hatchability trials, the egg shell conductances of Hole and No Hole eggs (n=15 per treatment) were determined. The data were analyzed using the GLM procedure of SAS, all percentage data were transformed using Arc-sine transformations prior to analysis, and probability was assessed at P #8804 0.05. As expected, the conductance of the Hole (16.0 ± 0.4) versus No Hole (14.8 ± 0.4) eggs was significantly greater (P = 0.0420). However, number of culled chicks, hatchability, and embryonic mortality, including late incubation mortality were not influenced by the increased conductance created by the hole (late mortality Hole = 8.5 ± 1.7; No Hole = 8.3 ± 1.7; P=0.9494). This data indicates that the increased gas conductance provided by the egg injection hole does not reduce late embryonic mortality as was hypothesized. Future studies should focus on effects of the egg injection hole on eggs with poor shell conductance, and on the potential effects on post-hatch survival and growth.

Key Words: Embryo Survival, Egg Injection, Egg Shell Conductance

268 Effect of hatch pull time, protein and methionine on bobwhite quail performance. J. P. Blake*, J. B. Hess, and W. D. Berry, *Auburn University, Auburn, AL.*

Limited information exists concerning management and nutritional requirements for commercially produced bobwhite quail. An experiment investigated the effects of delayed placement after hatching on livability and performance. Bobwhite quail eggs (500) were incubated on two consecutive days and all hatchlings were removed on the 25th day and identified as either early (ES) or late (LS) set of eggs. Bird numbers were c.a. 54 birds/pen with 8 reps/set. In addition, 4 reps/set were offered a top-dressed feed supplement (Oasis) for three days post-hatch. Birds were fed a 26% corn-soybean meal starter diet containing 2,811 kcal/kg ME. Brooding temperature was 35 C (95 F) for the first week and reduced 2.8 C (5 F) weekly through four weeks of age. Results indicate that LS hatchlings (day 0) were significantly (P<0.0001) heavier as compared to ES hatchlings (6.95 vs. 6.15 g/bird). However, by 7-d of age ES birds were significantly (P<0.001) heavier than LS birds (17.60 vs. 15.31 g/bird). This effect carried through to the 28th day, where ES birds were significantly (P<0.01) heavier than LS birds (85.54 vs. 81.85 g). Bodyweight gains exhibited a similar pattern where ES birds exhibited greater period or overall gains than LS birds. Feed consumption was also significantly greater (P<0.01) for the ES versus LS birds during the 28-d experimental period (173.5 vs. 167.0 g/bird, respectively). Using a feed scattered additive had a slight influence on reducing early mortality (P<0.10) and reducing feed requirements (P<0.05) from 0-14 days posthatch. At four weeks of age birds were congruently assigned to one of four nutrient regimens: 22% CP/0.50% met; 22% CP plus methionine; 18% CP/0.41% met; 18% CP plus methionine resulting in an increased methionine level of 0.12 and 0.09% for the 22 and 18% diet, respectively. No differences in bodyweight, bodyweight gain, feed

consumption, or feed efficiency occurred due to treatment. Qualitative feather scores obtained at termination of the experiment at ten weeks of age indicated that the 18% CP plus methionine group had a significantly lower ($P < 0.05$) score as compared to the other treatments.

Key Words: Bobwhite Quail, Incubation, Protein

269 Influence of light intensity and handling on live and processing performance of male broilers. R. J. Lien*, J. B. Hess, S. R. McKee, B. A. McCrea, and S. F. Bilgili, *Auburn University, Auburn, AL.*

To determine effects on live and processing performance, broilers were subjected to step-up lighting of either bright or dim intensity, and either no handling or handling by the legs or wings to evaluate susceptibility to deep pectoral myopathy and deep thigh bruising. Male broilers (Ross 508) were placed in 12 light-tight rooms (90 per room). Step-up lighting (23L:1D, 1-9 d; 12L:12D, 9-16 d; 14L:10D, 16-23 d; 17L:7D, 23-30 d; 20L:4D, 30-37 d; and 23L:1D, 37-51 d) was provided. Six rooms were provided a light intensity of 15 footcandles (FC) (bright). The other 6 were provided an intensity of 0.5 FC to 9 d and 0.1 FC thereafter (dim). Birds were gently handled by the body during weighings at 9 and 23 d. At 23 d, birds in each room were randomly divided into 3 equal groups, assigned to either no handling, leg handling, or wing handling treatments, and marked accordingly. At 37 and 44 d, leg and wing handling birds only were each held for 20 s by their legs or wings and then weighed. At 51d, all birds were gently handled by the body as they were quickly and carefully weighed. Relative to bright light, dim light increased BW by 5% from 23 to 51 d and total feed consumption per bird from 30 to 51 d by 4%; however feed conversion was unaffected. Handling did not influence BW. Uniformity was not influenced significantly by treatments. Mortality averaged 3.6% and was unaffected by treatments. Since carcass and parts yields were consistently the same in the two intensity treatments, differences in live weights carried over through processing. Therefore, lean carcass, wing, leg, breast fillet, tender, and total breast weights were all increased by dim light. Leaf fat weights did not differ between lighting treatments, but fat yield was greater due to bright light. Handling did not affect carcass and parts weights or yields. Providing 0.1 FC throughout most of the growing period increased BW and feed consumption, which resulted in greater carcass and parts weights without any impact on feed conversion or parts yields.

Key Words: Broiler, Light Intensity, Handling

270 Impact of genotype, growth profile and photostimulation age on the reproductive efficiency of female broiler breeders. R. A. Renema*¹, M. J. Zuidhof², and F. E. Robinson¹, ¹*University of Alberta, Edmonton, AB, Canada,* ²*Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.*

A 3 X 4 X 2 factorial design trial, with 3 broiler breeder strains, 4 target BW profiles and 2 photostimulation (PS) ages was performed to test the impact of strain and growth profile on sexual maturation traits. A total of 560 pullets from each strain (Hubbard Hi-Y, Ross 508, and 708) were housed in 24 pens. The BW profiles separated at 3 wk and converged at 32 wk of age as follows: STANDARD (approximates mean target BW profile of breeder strains used); LOW (12 wk BW target = 25% lower than STANDARD followed by rapid gain to 32 wk); MODERATE (12 wk BW target = 150% of STANDARD followed by lower rate of gain to 32 wk); and HIGH (12 wk BW target = 200% of STANDARD followed by minimal growth to 32 wk). Birds were photostimulated at 18 or 22 wk. Twelve birds per interaction were individually caged at 17 wk and monitored for egg production and fertility traits to 58 wk. The BW profiles converged at 32 wk and were similar thereafter. The LOW growth profile delayed onset of lay, particularly in 18 wk PS-age birds. There was no effect of growth history on initial egg weight. However, an 18 wk PS-age resulted in production of 16.0 small eggs (<52 g) compared to 7.9 in 22 wk birds. A settable, 52 g egg weight was reached earliest by STANDARD birds (26.7 wk of age). Prime laying sequence length was reduced by 7.0 eggs, on average, in MODERATE and HIGH birds (mean = 15.0 d) compared to other profiles ($P < 0.0001$). The 18 wk PS-age birds yielded 8 more eggs (170) than 22 wk PS-age birds, with no effect on unsettable eggs. On average, total egg production was similar among growth profile treatments. However, Ross 708-HIGH hens under-performed (138 eggs) compared to the other profiles (mean = 166.3). Alternatively, Ross 508-HIGH birds laid the same number of

eggs as Ross 508-STANDARD birds (mean = 178.7). Feeding profiles affected egg production traits differently among strains, with little effect of PS-age.

Key Words: Broiler Breeder, Growth Curve, Egg Production

271 Relationship of physical traits at hatch with growth traits to 14-d of age in male chicks of selected parent stock and pure line products. F. E. Robinson*¹, N. J. Wolanski¹, R. A. Renema¹, G. M. Fasenko¹, V. L. Carney², and B. Fanher², ¹*University of Alberta, Edmonton, AB, Canada,* ²*Aviagen, Huntsville, AL.*

Current commercial boiler breeder products are the result of specific strain crosses. This trial measured the relationship between chick morphology and quality with early male growth traits. Chicks of 8 strains (specialized and commercial lines) (110 birds/strain) were wing-banded and weighed at hatch. Chick length, shank length, navel score and abdominal score (for yolk-sac retention) were recorded. Fifty chicks/strain were dissected and breast muscle and yolk sac weighed. Remaining chicks of each strain were divided among 2 pens and reared under commercial conditions. At 14-d of age, 50 randomly selected chicks were dissected to assess the impact of strain on BW, frame size, breast muscle, and residual yolk-sac. The d0 chick weights varied, averaging a high of 40.6 g in Strains 1, 2, 4, and 9, 38.7 g in Strains 3 and 6, and a low of 37.1 g in Strains 7 and 8. Their abdominal score (range of 1-3) correlated with actual yolk-sac weight ($r = 0.50$; $P < 0.0001$). Once residual yolk sac (range of 5.8 g [Strain 4] to 3.0 g [Strain 8]) was removed, variability in chick weight dropped from 4.2 to 2.4 g among Strains. Yolk-sac weight did not impact rate of BW-gain to 14 d. Strains 1 and 4 (mean yolk-sac weight of 14.5%) grew fastest and slowest, respectively, with an identical breast muscle yield at d14 (12.0%). Residual yolk at d14 was low (0.04 [Strain 8] to 0.43 g [Strain 1]), but with a similar profile to d0 values. Both shank length ($r = 0.43$) and chick length ($r = 0.38$) at d0 correlated better with d14 BW than initial chick weight did ($r = 0.34$). The BW:shank ratio and BW:length ratio at d0, which may adjust for some strain or size differences, were no better correlated with d14 BW than d0 BW was (mean $r = 0.33$). Good navel condition at hatch was linked with improved relative growth to 14 d ($P = 0.009$), while red hocks did not affect growth ($P = 0.29$). This trial demonstrated variability in the effect of chick traits on early growth patterns in current stocks.

Key Words: Chick Quality, Growth Rate, Strain Variation

272 Growth potential and carcass characteristics of eight strains of broiler breeder stocks. M. E. Rustad*¹, F. E. Robinson¹, R. A. Renema¹, M. J. Zuidhof², and V. L. Carney³, ¹*University of Alberta, Edmonton, AB, Canada,* ²*Alberta Agriculture Food and Rural Development, Edmonton, AB, Canada,* ³*Aviagen, Huntsville, AL.*

Over the past 30 years there has been an increase in genetic progress of growth rate and breast meat yield of broiler stocks. This has led to the development of market specific strains which provide challenges for managing breeder stocks. This trial was carried out to determine the relative growth and breast yield potential of commercial and specialized broiler lines to aid in development of effective weight management strategies. Eight strains of broiler pullets (12 birds/strain) were placed in eight pens (96 birds/pen). Birds were provided ad libitum access to feed and water, and given a constant 23L:1D of light. Weekly pen weights were taken from 0 to 84 d. At 42d and 84d, six birds from each strain were removed from each pen and assessed for external fleshing traits, processed, and weights of the P. major, P. minor, and fatpad were determined.

At 6 wk and 12 wk, the heaviest strain was Strain 1 (2.59kg & 5.24kg) and the lowest was Strain 4 (1.78kg & 3.66kg). Strain 4 birds had the highest % breast muscle at both testing periods (12-wk: 27.3% of the live BW). Strain 3 and 6 were the lowest yielding strains at 6 and 12wk (20% of live BW). At 6 & 12 wk strain 3 showed the smallest breast depth (1.3 & 2.2mm). Strain 4 showed the lowest % fat pad (1.82% of live BW), while Strain 3 was the highest (4.30%). Strain 1 had consistently higher values for chest girth, keel and shank length than all other strains, but ranked fourth in breast yield (24.2%). Because strain 4 show the highest percentage of breast yield with the smallest frame size and a large breast width, this indicates that these birds are increasing breast muscle in adding width rather than by linear growth of the keel. This trial demonstrated the variability of breast muscle deposition, growth

patterns, fat deposition and carcass traits of differing broiler breeder genotypes.

Key Words: Broiler Growth, Breast Muscle Yield, Strain Variation

273 The effects of supplemental enzyme (AVIZYME 1502) and phytase (PHYZYME) on phosphorus nutrition in broiler breeders. M. S. Lilburn*¹, A. Mitchell², and E. E. M. Pierson³, ¹Ohio State University, Wooster, ²Growth Biology Lab, USDA, Beltsville, MD, ³Danisco Animal Nutrition, St. Louis, MO.

Broiler breeder pullets were fed diets with two levels of phosphorus and supplemental amylase or phytase or the combination. A Control diet was formulated to contain 0.40 available phosphorus with no added enzymes. A second series of diets were formulated to contain 0.30% available phosphorus with either supplemental PHYZYME (phytase), supplemental AVIZYME (avizyme) or PHYZYME plus AVIZYME (combination). Pullets were restrict fed beginning at 14 days of age. At 6 weeks, 12 pullets per dietary treatment were put into individual cages in Petersime growing batteries. The pullets were put in the cages on an off-feed day. They were individually fed 72 grams of the respective diets and excreta was collected from individual pullets over the next 48 hours. The phytase and combination diets resulted in a significant drop in total excreta dry matter (Control, 17.6 gm; phytase, 16.7 gm; avizyme 17.7 gm; combination, 16.5 gm). All three enzyme treatments resulted in a significant drop in excreta phosphorus concentration but this was expected as available phosphorus was also lower in these treatments (Control, 17.6 mg P per gm excreta; phytase, 14.5; avizyme, 15.1; combination, 13.1). Total phosphorus output was as follows: Control, 311 mg P; phytase, 243 mg P; avizyme, 267mg P; combination, 215 mg P. In conclusion, the use of low available phosphorus diets together with supplemental phytase and the combination of phytase resulted in a linear decline in total excreta phosphorus output by restrict broiler breeder pullets

Key Words: Broiler Breeders, Phosphorus, Phytase

274 Detection of *Campylobacter* and *Salmonella* in the mature and immature ovarian follicles of late-life broiler breeder hens. N. A. Cox¹, J. S. Bailey¹, L. J. Richardson*¹, R. J. Buhr¹, K. L. Hiatt¹, D. E. Cosby¹, J. L. Wilson², G. R. Siragusa¹, D. V. Bourassa², and M. T. Musgrove¹, ¹USDA-ARS, Russell Research Center, Athens, GA, ²Department of Poultry Science, University of Georgia, Athens.

Campylobacter and *Salmonella* are known to cause acute bacterial gastroenteritis in humans. Poultry products have been implicated as a significant source of these infections. Four trials were conducted to determine if *Campylobacter* and *Salmonella* spp. exist naturally in the mature and immature ovarian follicles of late-life broiler breeder hens. Broiler breeder hens ranging from 60-66 weeks of age were obtained from four different commercial breeder operations. For each trial, the hens were removed from the commercial operation and held overnight at the University of Georgia processing facility. The hens were euthanized, de-feathered and aseptically opened. To reduce the possibility of cross-contamination between samples, the mature and immature ovarian follicles were aseptically removed, then the ceca. Individual samples were placed in sterile bags, packed on ice and transported to the laboratory for evaluation. Overall, *Campylobacter* was found in 5/43 immature follicles, 9/35 mature follicles and 30/43 ceca. *Campylobacter* was found in at least one of each sample type in each of the four trials. *Salmonella* was found in 0/43 immature follicles, 1/35 mature follicles and 8/43 ceca. In this study the recovery rate of *Salmonella* from late-life broiler breeder hen ovarian follicles was relatively low. However, the recovery rate of *Campylobacter* from the hen ovarian follicles was reasonably high suggesting that these breeder hens could be infecting fertile hatching eggs. Determining how *Campylobacter* contaminated these ovarian follicles and how many chicks may become colonized from this source are the next steps in helping to elucidate a better understanding of this ecology and control of *Campylobacter* in poultry production.

Key Words: *Campylobacter*, *Salmonella*, Ovarian Follicles

275 The effect of daily photoperiod on growth of commercial broilers. 1. Body weight and breast yield. M. S. Lilburn*, Ohio State University, Wooster.

The broiler industry has successfully used daily photoperiod as a tool in the control of growth related anomalies ranging from leg disorders to ascites. There is an increasing trend, however, to impose restricted photoperiods at increasingly younger ages and this may have negative effects on other aspects of live production. Eggs were purchased from an integrated company that was experiencing excessive 7 and 14 day mortality. Each egg was weighed at set (n=1060 eggs) and transfer (19 days). Moisture loss at 19 days was 11.75% and shell weight determined on a random sample of eggs was above 9% of egg weight. At hatch, chicks were equally divided among two light controlled rooms. In Room A, the daily photoperiod was 24 hours through 4 days of age and then decreased to 16 hours on Day 5. In Room B, the photoperiod was decreased to 23 hours on Day 5. All the birds in each room were weighed at 7, 14, 21, and 28 days of age. On days 42 and 43, half the birds in each photoperiod were weighed and processed for pectoralis major and minor breast muscle determination. The sex of each bird was visually determined and recorded. The 23 hour photoperiod resulted in a significant increase in body weight at 14,21 and 28 days of age. At processing, the 23 hour photoperiod resulted in significantly heavier body weight (2605 vs 2555 gm) and increased weight of the pectoralis major (197 vs 189 gm). The males weighed 2826 gms versus 2337 gm for the females with corresponding pectoralis major weights of 213 and 174 gms. In summary, a reduction in daily photoperiod from 24 to 16 hours at a very young age resulted in a significant reduction in body weight from 14 through 42 days of age. The proportional reduction in body weight was less than the proportional reduction in relative weight of the pectoralis major breast muscle.

Key Words: Photoperiod, Growth, Broilers

276 The effect of daily photoperiod on growth of commercial broilers. 2. Feeding behaviour. K. Huffman* and M. S. Lilburn, Ohio State University, Wooster.

Two experiments were conducted with broilers to study the effects of different photoperiods on feed intake behaviour during the first hour of the daily photoperiod. Twenty broiler chicks were randomly allotted, at a day of age, to litter floor pens (4.64 m²) in each of two light controlled rooms. The pens were arranged in observation groups of three pens, two pens with chicks (A,B) on either side of an empty observation pen There were three observation groups in each room. At 4 days of age, the daily photoperiod in one room was decreased from 24 to 16 hr beginning at 0900 hrs. In the second room, the daily photoperiod was decreased to 22 hrs beginning at 1300 hrs. This allowed each room to be observed on the same day and weekly observations were done on Monday, Wednesday, and Friday of each week beginning at 7 days of age. The first hour of the daily photoperiod was divided into 10, 6 minute periods. The number of chicks feeding was visually determined in Pen A (4 to 5 min) and Pen B (5 to 6 min) during each of the 10 observation periods. The data for each week was the average of the three observation days X two pens per day (n=6 total observations per week per room). Experiment 2 was conducted to increase the number of replicate pens observed per week. The data was analyzed using the Proc GLM procedure of SAS. The main effects tested were experiment, photoperiod, age (week) and the interactions of experiment X week and photoperiod X week. In both treatments, the greatest feeding activity occurred during the first 6 minutes of the daily photoperiod. There were significantly more birds eating in the 22 hr treatment during the initial 6 minute observation period (16 hr = 7.4; 22 hr = 8.9; P < .002) and these numbers were almost halved during the second observation period (16 hr = 4.3, 22 hr = 4.7; P > .05). During each of the remaining 8 observation periods, there were significantly more birds from the 16 hr treatment consuming feed (range 4.1 to 4.8) than in the 22 hr treatment (range 2.4 to 3.4). There were significant experiment effects for most of the observation periods but no consistent experiment X week or photoperiod X week interactions

Key Words: Feed Intake, Photoperiod, Behaviour

277 The effect of daily photoperiod on growth of commercial broilers. 3. Skeletal development. M. S. Lilburn*¹ and A. Mitchell², ¹Ohio State University, Wooster, ²Growth Biology Lab, USDA, Beltsville, MD.

Broiler starter diets from three commercial feed mills (same company, different locations) were fed to day-old Hubbard Hi-Y broiler chicks along with a Control diet manufactured at Ohio State University. The analyzed calcium levels were as follows: Source 1, .76% ; Source 2, .97% ; Source 3, .81% ; Control, .98%. Each of the diets was fed to 5 replicate pens of broiler chicks in Petersime battery brooders in each of two light controlled rooms. In Room A, the chicks were exposed to a 24 hr photoperiod from 0 to 4 d and 22 hr from 5 to 21 d whereas in Room B, the photoperiod was decreased to 16 hr at 5 d of age. At the end of the study, each chick was weighed and the tibia and femur were removed for length, width @ 50% of length, defatted dry weight and bone mineral content. Chicks exposed to 16 hr of light weighed significantly less than those chicks exposed to 22 hr (706 vs 747 g; P < .0001). The 16 hr photoperiod also resulted in a significant decrease (P < .01) in all bone measurements: tibia wt, 1.58 vs 1.78 g; tibia length, 6.34 vs 6.48 cm; tibia width, 5.8 vs 6.0 mm; femur length, 4.82 vs 4.93 cm; femur width, 6.7 vs 7.1 mm. Tibia and femur bone mineral content and bone mineral density were significantly greater in birds fed the Source 2 and Control diets compared with birds fed the Source 1 and Source 3 diets. These same bone mineral measurements were consistently higher in the 22 h. photoperiod though the differences were not always significant. In conclusion, variability in commercial starter diets combined with early photoperiod restriction may have a negative effect on skeletal development in broilers.

Key Words: Bone, Photoperiod, Calcium

278 Spatial disparity of ammonia flux within a broiler house at one and 21 days of age. D. M. Miles*¹, P. R. Owens¹, D. E. Rowe¹, and S. L. Branton², ¹USDA-ARS, Waste Management and Forage Research Unit, Mississippi State, MS, ²USDA-ARS, Poultry Research Unit, Mississippi State, MS.

Ammonia concentrations greater than 25 ppm in broiler houses have been linked to emaculated birds. The objectives of this study were to measure ammonia and other gas fluxes in a commercial broiler house and assess any spatial variabilities. Application of these findings include the development of optimum sampling methods as well as the identification of characteristics of modern tunnel ventilated houses that contribute to gas emissions. Researchers hypothesize that litter age, moisture, pH, temperature, and airflow patterns affect gas flux values and these parameters vary spatially. Ammonia, nitrous oxide, carbon dioxide, methane, and carbon monoxide were measured using a photoacoustic multigas analyzer along with flux boxes. Samples (n=36) were collected systematically throughout the house along a set grid. Twenty-eight flocks had been grown on the litter prior to the summer flock sampling with chicks in the house at one (placement) and 21 (mid-growout) days of age. At one day of age during half-house brooding, average NH₃ flux was 498 mg/m²-hr for the brood area and 372 mg/m²-hr for the vacant end of the house with peak areas near the middle of the cool cell end (where airflow is not well established) and near the north side wall (an area of high litter moisture, 37%). At 21 days of age, litter temperatures were reversed from those at chick placement and were greater near the fan end of the house. Both ranged from about 25.6 to 31.9 C. Litter pH was greater in the nonbrood half of the house at placement and mid-growout. Average NH₃ flux for the mid-growout was 136 and 310 mg/m²-hr for the brood and fan ends. A peak area for NH₃ flux in mid-growout was evident approximately 7 m past the midpoint of the house (towards the fans) and correlated to high pH (8), high litter moisture (33%), and high CO₂ flux (12500 mg/m²-hr). The spatial variability of these parameters demonstrates that increased NH₃ flux relates to high litter moisture as well as greater litter temperatures and CO₂ flux and NH₃ flux decreases on average from placement to mid-growout.

Key Words: Ammonia, Broiler, Emissions

PSA Immunology

279 Salmonella vaccination programs in broiler breeders. I. Humoral and mucosal immune response. A. Rolon*¹, J. S. Bailey², P. S. Holt², C. L. Hofacre³, J. L. Wilson², D. E. Cosby², L. J. Richardson², and N. A. Cox², ¹Department of Poultry Science, University of Georgia, Athens, ²U. S. Department of Agriculture Russell Research Center, Athens, GA, ³Department of Avian Medicine, University of Georgia, Athens.

Although vaccination against *Salmonella* has been used more frequently in broiler breeders in recent years, there is a paucity of information in the literature demonstrating the immunological response of treatments that combine live and autogenous killed cell vaccines. The present research was designed to assess the immunological response that was generated by three vaccination protocols. Treatment vaccines consisted of a live Aro-A mutant commercial *Salmonella* Typhimurium (ST) vaccine and an autogenous killed vaccine consisting of a pool of *Salmonella* serovars Berta, Heidelberg, and Kentucky prepared by a commercial company. Four groups of 250 Cobb x Cobb breeder chicks were vaccinated as follows: A) 2 live (day 1 and 21) and 2 killed (day 77 and 126); B) 3 live (day 1, 21, and 77) and 1 killed (day 126) and ; C) 2 killed (day 77 and 126); and D) untreated controls. To assess humoral and mucosal immune response, samples of serum (SER), crop lavage (CL), gut lavage (GL), hatchling serum (HSER), and egg yolk (EY) were tested to measure IgA and IgG. ELISA for IgA and IgG on *Salmonella* Enteritidis and *Salmonella* Typhimurium lypopolysaccharide (SELPS and STLPS) as capture antigen were conducted. Overall, immunological response was stronger on STLPS than SELPS. IgA of SER, CL and GL as well as IgG of CL were short-lived peaks after first killed vaccine. Strong GL IgG after first live and both killed vaccine events were measured with the killed response enduring longer. SER IgG responses were observed after killed vaccine events, and lasting throughout 40 wk of age. HSER and EY IgA were negligible, and IgG comparable among all treatments throughout time. These results show that killed antigen is vital in eliciting adequate IgG in serum and gut. Live vaccination with Aro-A mutant

ST vaccine enhances gut IgG and possibly aids in conferring adequate immunity during the breeder's first weeks of life.

Key Words: *Salmonella*, Vaccination, Immune Response

280 Salmonella vaccination programs in broiler breeders. II. Resistance to challenge under a multiple marker strain model. A. Rolon*¹, J. S. Bailey², P. S. Holt², C. L. Hofacre¹, J. L. Wilson², D. E. Cosby², L. J. Richardson², and N. A. Cox², ¹University of Georgia, ²U. S. Department of Agriculture.

Resistance to *Salmonella* challenge of breeders and their chicks under three vaccination programs was assessed. Vaccine protocols combined a live Aro-A *Salmonella* Typhimurium (ST) vaccine and an autogenous 3-serovar killed vaccine. Treatments combined: 2 live and 2 killed or 3 live and 1 killed vaccines delivered at 1 d and 3, 11 and 17 wk of age; 2 killed vaccines given at d 77 and 126; and a non-vaccinated control (C). Breeders were gavaged with 10⁷ cells of a 3-strain cocktail (*Salmonella* Enteritidis (nalidixic acid resistant, Nal-SE), Typhimurium (rifampicin resistant, Rif-ST) and Thompson (ampicillin resistant, Amp-STH)), at wk 3, 6, 10 18 and 22. Chicks from eggs laid at wk 29, 34 and 40 of breeder age (BA) were challenged at one day-of-age. Chicks were divided in two groups per treatment, one given a commercial competitive exclusion culture (CE), and both were challenged with 10⁷ cells of a Nal-SE + Rif-ST + Amp-STH cocktail and kept in isolation units for one and two wk. Ceca and Liver-Heart-Spleen (LHS) samples were cultured for each marker strain on BGS + antibiotic (Nal, Rif, or Amp) plates and colonies counted after 24h incubation. Log₁₀ data were analyzed under a factorial design. Breeder *Salmonella* counts showed significant differences between (live) vaccinates and non-vaccinates at 3 and 6 wk challenges. By 10 wk, there were no discernible difference in *Salmonella* level in challenge and control chicks, indicating protection by (1d and 3 wk) live vaccines had diminished at this time. All programs reduced breeder *Salmonella* counts compared to controls at 22 wk. Chick *Salmonella* counts showed little consistency between vaccine treatments. At 34 and

40 wk BA, no difference was observed in susceptibility of chicks from vaccinated and control breeders. Passive immunity did not show consistent decrements on challenged chicks *Salmonella* counts. These results show that live vaccination with the Aro-A ST vaccination decreases *Salmonella* counts during the first 6 wk of age of the breeder, as do all programs by 22 wk of age, and that competitive exclusion is the most effective treatment in reducing *Salmonella* counts.

Key Words: *Salmonella*, Broiler Breeders, Competitive Exclusion

281 Construction and evaluation of recombinant *Salmonella* vaccine expressing *Eimeria* sporozoite and merozoite antigen. V. Konjufca*, S.-Y. Wanda, and R. Curtiss III, *Washington University, St. Louis, MO.*

Coccidiosis is a poultry disease caused by ubiquitous protozoan parasite *Eimeria* sp. and is characterized by intestinal lesions, poor growth, morbidity and mortality. Efforts to produce an effective vaccine against this disease have been with limited success and the need for an effective vaccine is still evident. *Eimeria* is an intestinal parasite, thus a vaccine capable of inducing both mucosal and systemic immune responses would be most effective in protecting against this parasite. Our approach uses the *Salmonella* Type Three Secretion System (TTSS) to deliver an antigen directly into the cell cytoplasm of the immunized host to result in MHC class I antigen processing for induction of antigen-specific CTL responses. To accomplish this goal, *Eimeria* genes encoding antigens EASZ240 and EAMZ250 were fused to *Salmonella* effector protein gene *sptP* in the parental Asd⁺ pYA3653 vector, yielding pYA3657 and pYA3658, respectively. SptP effector protein is secreted by TTSS of *Salmonella* and translocated into the cytosol of immunized host cells. The host-strain chromosomal copy of the *sptP* gene was deleted and replaced by a reporter gene *xylE*. Newly constructed pYA3657 and pYA3658 were introduced into host strain χ 8879 (Δ phoP233 Δ sptP1033::xylE Δ asdA16). This strain is an attenuated derivative of highly virulent *S. typhimurium* UK-1 strain. In vitro experiments show that EASZ240 is secreted into the culture medium by TTSS without contact with eukaryotic cells. In addition, EASZ240 is delivered into the cytoplasm of Int-407 cells by TTSS, making this protein a good model antigen for evaluation of TTSS as an antigen delivery system. Colonization of bursa, spleen and liver by all three vaccine constructs were observed in immunized day-old chicks with peak titers at 6 to 9 days post-immunization. In vivo experiments indicate that both humoral and cell-mediated immune responses were induced in vaccinated chickens.

Key Words: *Eimeria*, Vaccine, *Salmonella*

282 Rous sarcoma growth in lines congenic for major histocompatibility (B) complex recombinants. E. S. Schulten¹, W. E. Briles², and R. L. Taylor, Jr.*¹, ¹University of New Hampshire, Durham, ²Northern Illinois University, DeKalb.

Six congenic lines of chickens with major histocompatibility (B) complex recombinant haplotypes were examined for Rous sarcoma virus (RSV) tumor growth. These lines were created by crossing a male bearing each B complex recombinant (R¹ - R⁶) to highly inbred Line UCD 003 (B¹⁷B¹⁷) females, which constitute the genetic background. Backcrosses were made by crossing recombinant heterozygous males (R^{B17}) to UCD 003 females. After the tenth backcross, heterozygotes for each recombinant were mated to produce homozygous progeny for one of six different recombinants with 99.9% of their background genome from Line UCD 003. The MHC recombinant haplotypes for these lines were: R¹=B-F/B-L²⁴, B-G²³; R²=B-F/B-L², B-G²³; R³=B-F/B-L², B-G²³; R⁴=B-F/B-L², B-G²³; R⁵=B-F/B-L²¹, B-G¹⁹; and R⁶=B-F/B-L²¹, B-G²³. R², R³, and R⁴ (all B-F/B-L², B-G²³) are distinct recombinants because each haplotype arose from separate recombinational events. Chicks from each line were challenged with 10 pfu of subgroup A RSV. Tumors were assigned tumor size scores at 2, 3, 4, 6, 8, and 10 weeks post-inoculation. Each bird was assigned a tumor profile index (TPI) number based on the six tumor size scores. Hatch and B genotype were main effects in the statistical analysis. Least squares ANOVA was used to evaluate rank transformed TPI values and mean tumor sizes through a repeated measures design. Fisher's Protected LSD at P < 0.05 separated significant means. R¹R¹ and R⁴R⁴ chickens had greater tumor growth and significantly higher TPI than the other four recombinant lines. R¹R¹ has B-F/B-L²⁴, a previously characterized progressive haplotype. The higher tumor growth and TPI of R⁴R⁴

indicates the presence of different genes affecting RSV tumors compared to the serologically-similar R²R² and R³R³. The similar tumor growth of R⁵R⁵ and R⁶R⁶ shows no B-G region effect.

Key Words: B complex, Oncogene, Tumor

283 Demonstration of Carboxypeptidase E protein and mRNA in the diffuse neuroendocrine system of the chicken thymus. X. Zhang*², J. J. Zhu¹, and L. R. Berghman¹, ¹Departments of Poultry Science and Veterinary Pathobiology, Texas A&M University, College Station, ²Department of Poultry Science, Texas A&M University, College Station.

In previous studies, we have described a complex neuroendocrine cell population within the chicken thymus using a monoclonal antibody against avian chromogranin A (CgA). CgA is considered an on/off switch in neuroendocrine cells, controlling the biogenesis of large dense-core vesicles (LDCV) and essential for the regulated secretory pathway. Here, we report that most of the CgA-positive cells are also immunoreactive for carboxypeptidase E (CpE), a processing enzyme present in the Golgi and secretory granules of neural/neuroendocrine cells that is necessary for the post-translational maturation of prohormones into bioactive peptides. Our immunofluorescent dual staining experiments used antisera against the conserved C- and N-terminal portions of CpE, respectively, (kindly donated by Dr. Peng Loh, NIH) and a monoclonal antibody against avian chromogranin A on chicken thymus sections. Surprisingly, the antisera against the respective CpE termini did not produce identical staining patterns. Co-localization of C-terminal CpE immunoreactivity was observed in most, if not all, CgA positive cells. In contrast, the antiserum against N-terminal CpE clearly identified cells but also nerve fibers, and N-terminal CpE immunoreactivity was generally not co-localized with CgA. This seems to suggest the existence of different CpE isoforms in the chicken thymus. Based on chicken genome sequence data, the synthesis of both CgA- and CpE-specific mRNA in the chicken thymus was confirmed by RT-PCR. The observed neuroendocrine cells were located predominantly in the transition zone between the cortex and the medulla of the thymic lobules, which is known to be heavily innervated by the autonomic nervous system. These findings fit with our current working hypothesis that some of the locally produced neuroendocrine molecules are processed and released through the regulated neuroendocrine secretory pathway, potentially under the control of the autonomic nervous system.

Key Words: Chicken, Thymus, Carboxypeptidase E

284 Cationic amino acid transport (CAT) expression in immune tissue and the effect of lysine on lymphocyte function. B. Humphrey* and K. Klasing, *University of California, Davis.*

Lysine and arginine are transported into cells by cationic amino acid transporters (CAT). Two experiments determined the effect of the acute phase response (APR) on CAT expression and the effect of lysine levels on lymphocyte proliferation. The first experiment was designed as a 2 x 2 factorial with fasting or feeding and 2 levels of LPS (+/- LPS; 1mg/kg BW s.q.). Treatments were initiated when broiler chicks were 2 weeks of age and samples were collected 12-h later. Plasma amino acids were determined and bursa, thymus and liver CAT1-3 mRNA levels were assayed by quantitative PCR. Plasma lysine and arginine levels were increased by both LPS and fasting (P<0.05). Bursa and thymus CAT-1 levels did not change with fasting (P>0.05) and increased 5-fold with LPS (P<0.05). Bursa and thymus CAT-2 levels did not change with fasting (P>0.05) and decreased below the limit of detection with LPS. Thymus CAT-3 levels in fasting chicks decreased 1.4-fold with an LPS injection (P=0.05). Bursa CAT-3 levels in fasting chicks decreased 2-fold with an LPS injection (P<0.05). Experiment two determined thymocyte proliferation in response to 4 lysine levels (no lysine, 0 μ M; lysine deficient, 50 μ M; lysine adequate, 500 μ M; lysine APR, 1500 μ M) and 2 levels of PHA (0 or 30 μ g/ml). In vitro lysine levels were similar to in vivo lysine levels for each indicated physiological state. Thymocytes proliferated in response to PHA at all lysine levels except for 0 lysine (P<0.05). Proliferation at 500 μ M lysine was greater than 50 μ M (P<0.05) and tended to be greater than 1500 μ M (P=0.06). During the APR, the bursa and thymus increase their transport capacity for lysine and arginine while the levels of these nutrients increase in plasma. In addition to providing increased lysine and arginine for use in nitrogen metabolism, increased transport capacity of lysine by the thymus may also serve to suppress T

lymphocyte responses since thymocyte proliferation tended to be lower with lysine concentrations at 1500 μ M.

Key Words: Acute Phase Response, Lysine, Lymphocyte

285 Effect of testosterone and lead on T cell maturation in the developing thymus. I. Hussain*, M. Piepenbrink, and R. Dietert, *Department of Microbiology and Immunology, College of Veterinary Medicine, Cornell University, Ithaca, NY.*

The developing immune system is particularly sensitive to environmental and hormonal influences. Genders can differ in this sensitivity as well. Because the heavy metal, lead, can suppress Th-1 associated function among perinatal thymocytes and cause a systemic loss of postnatal Th-1 function, we investigated the ability of *in ovo* administered lead and testosterone to alter thymocyte maturation. Cornell K-strain chick embryos were injected via the air sac on embryonic (E) day 8 with either testosterone (12.5 μ g/egg in ethanol) or 15% ethanol in 100 μ l volume. The groups then received either lead acetate (200 μ g/egg) or sodium acetate (control) on E 12 of incubation by the same route. On E 20, thymuses from 4-5 female embryos per group were harvested in sterile Hanks balanced salt solution on ice, and thymocytes were separated using Ficoll. Tri-color flow cytometry was performed with fluorescent-conjugated antibodies against chicken-CD3, CD4, CD8, TCR1 and TCR2 surface molecules and data were analyzed using the MIXED procedure of SAS. Lead did not induce changes among the cell surface markers measured in this study. However, testosterone administration caused changes in both the CD4+CD8+ and CD4+CD8- cell populations ($P \#8804$ 0.05). Testosterone treatment followed either by sodium or lead acetate injection caused a statistical increase in CD4+CD8+ cells (73.23 ± 2.77 % and 79.85 ± 2.77 % with sodium or lead acetate, respectively) compared either with ethanol and sodium acetate or ethanol and lead acetate treatments (69.68 ± 2.77 % or 68.98 ± 2.77 %, respectively). Additionally, testosterone treatment significantly lowered the percentage of CD4+CD8- cells from 7.61 ± 1.3 % (control)

to 4.2 ± 1.3 % or 4.63 ± 1.3 % (for testosterone with either sodium acetate or lead acetate, respectively). Therefore, sex hormonal balance can modulate thymocyte maturation, but cellular validation of lead-induced alterations would require the use of additional Th-specific markers. Supported by USDA grant NE-60/NE-1016.

Key Words: Immune Development, Thymus, Cell Populations

286 Immunocompetence measurements of frizzle and normally feathered genotypes issued from different maternal lines of chicken. M. M. Fathi, S. A. El-Safy*, and A. Galal, *Poultry Prod. Dept, Faculty of Agric., Ain Shams University.*

An experiment was conducted on frizzled and normally feathered genotypes issued from two different maternal lines either Golden-Montazah (GM), an Egyptian local breed, or Brown Hy-Line strains during the summer season of Egypt. The immunocompetence parameters that were assessed for the offspring were lymphoid organ weights, cell-mediated immune response (PHA-P), globulin level in serum and heterophil/lymphocyte ratio. The results of CBH response showed that the frizzled genotypes had a significantly greater dermal swelling response to PHA-P compared to normally feathered sibs. The frizzled genotypes also exhibited larger bursa and thymus (as a percentage of body weight) compared to the normal genotypes in the two dam lines. A significantly genotype-dam line interaction for globulin level was observed. However, the frizzle gene increased globulin level in chickens issued from GM dams and the reverse was true in chickens issued from Hy-Line. The H/L ratio was significantly higher in both genotypes of Hy-Line dams compared to counterparts of GM ones. We concluded that under the conditions of the current study, the frizzle chickens are hyper-responders compared to normal plumage birds, especially those issued from Golden-Montazah breed.

Key Words: Frizzle Gene, Immunocompetence Parameters, Maternal Lines

PSA-Nutrition: Feed Additives and Phytase

287 *In vitro* and *in vivo* evaluation of simultaneous supplementation of α -galactosidase and citric acid on nutrient release, digestibility and growth performance of broiler chicks. T. Ao*¹, A. H. Cantor¹, A. J. Pescatore¹, M. J. Ford¹, and J. L. Pierce², ¹University of Kentucky, Lexington, ²Alltech Biotechnology Center, Nicholasville, KY.

Experiments were conducted to evaluate the effects of simultaneous supplementation of α -galactosidase and citric acid on 1) *in vitro* nutrient release from soybean meal, and 2) *in vivo* nutrient digestibility and growth performance of broiler chicks fed a corn-soy diet. In Experiment 1, an *in vitro* model was used to simulate the chicken's digestive process in the crop and from the crop through the small intestine. Graded levels of α -galactosidase (0 to 13,792 units/kg) and citric acid (0 or 20 g/kg) in a factorial arrangement were added to soybean meal, which was used as the substrate. Reducing sugars were measured at the end of both phases. Increasing enzyme levels linearly ($P < 0.001$) increased release of reducing sugars in both phases. Addition of citric acid with α -galactosidase further increased enzyme activity, resulting in a significant interaction ($P < 0.001$). In Experiment 2, 144 1-d-old male broiler chicks were randomly distributed among 24 replicate cages of six chicks contained in three blocks, to provide six replicate groups for each of four treatments. Two levels of α -galactosidase (0 or 1724 units/kg) and of citric acid (0 or 20 g/kg) were added in a factorial arrangement to a low-energy (2730 Kcal ME/kg) corn-soy diet. Alpha-galactosidase ($P < 0.05$) increased body weight gain, feed intake, NDF digestibility and dietary AME_n. Citric acid increased ($P < 0.05$) the digestibility of DM, NDF and CP. Compared with the unsupplemented diet, weight gain and feed intake were depressed ($P < 0.01$) by adding citric acid alone, but not by the addition of both citric acid and α -galactosidase. Simultaneous supplementation of α -galactosidase and citric acid increased ($P < 0.05$) dietary AME_n and digestibility of DM, NDF, and CP, and improved ($P < 0.05$) feed to gain ratio. These results suggest that acidification of poultry diets may improve the effectiveness of exogenous α -galactosidase.

Key Words: Alpha-Galactosidase, Citric Acid, Broilers

288 Effect of virginiamycin in diets with adequate or reduced dietary calcium or available phosphorus for 0 to 18 d-old broilers. T. O'Connor-Dennie* and L. L. Southern, *LSU Ag Center, Department of Animal Science, Louisiana State University, Baton Rouge.*

Based on previous research in our laboratory, the addition of virginiamycin (Vm) to diets with reduced available P (aP) or Ca improved the negative effects associated with deficiencies of these minerals. To further investigate this response, two additional experiments (EXP) were conducted to evaluate the effect of Vm in diets with adequate or reduced Ca (EXP 1) or aP (EXP 1 and 2) on daily gain (ADG), daily feed intake (ADFI), gain:feed, bone breaking strength, bone ash percentage, and mg of ash in 0 to 18 d-old chicks. In EXP 1, there were six treatments with six replications of five chicks per replicate. The dietary treatments were: 1) a corn-soybean meal (C-SBM) diet with 1.00% Ca and 0.45% aP; 2) C-SBM with 0.70% Ca and 0.45% aP, 3) C-SBM with 1.00% Ca and 0.25% aP; Diets 4 to 6) as Diets 1 to 3 with 9 ppm Vm. Reducing dietary aP decreased ADG, ADFI, and BS ($P < 0.01$). Reducing dietary Ca decreased BS and gain:feed ($P < 0.06$) but had no effect on ADG or ADFI. The addition of Vm to the low aP diets tended to decrease BS (aP x Vm, $P < 0.06$) but had no effect on ADG or ADFI. The addition of Vm to the low Ca and control diets increased BS ($P < 0.03$). In EXP 2, there were twelve treatments with six replications of six chicks per replicate. The dietary treatments were: Diets 1 to 4) C-SBM with 1.00% Ca and 0.15, 0.25, 0.35, 0.45% aP; Diets 5 to 8) as Diets 1 to 4 with 11 ppm Vm; and Diets 9 to 12) as Diets 1 to 4 with 22 ppm Vm. Daily gain, ADFI, gain:feed, BS, bone ash percentage, and mg of ash per tibia were increased ($P < 0.01$) as dietary aP levels were increased. The addition of Vm, regardless of supplementation level, increased ADG and BS in chicks fed diets with 0.35% and 0.45% aP, but Vm had no effect or decreased ADG and BS at the 0.15 and 0.25% aP levels (aP x Vm, $P < 0.05$). These results indicate that Vm, added at 11 or 22 ppm, will partially overcome the negative effects associated with aP deficiency at dietary levels of 0.35% aP or greater.

Key Words: Chicks, Phosphorus, Virginiamycin

289 Intestinal bacterial populations in broiler chickens fed on high protein diets with and without added guar gum. J. P. Dahiya*, D. C. Wilkie, A. G. Van Kessel, B. Laarveld, and M. D. Drew, *University of Saskatchewan, Saskatoon, SK, Canada.*

Necrotic enteritis is a worldwide poultry disease caused by *Clostridium perfringens*. An experiment was conducted to study the effects of dietary protein level and source and a soluble non-starch polysaccharide (guar gum) on the intestinal populations of various microbes in broiler chickens. Six groups of 12 birds (in duplicate) were provided with a medicated ideal protein-balanced corn-based starter crumble from day 0 to 21 of age. From d 21 onwards, six experimental diets (23, 40, 40% crude protein) with fish meal and soybean meal as main protein sources and with and without added 1% guar gum were fed in a 2 X 3 factorial arrangement of treatments. All birds were orally challenged with *C. perfringens* type A both culture from d 21 to 27. Total anaerobes, *C. perfringens*, total aerobes and *Lactobacilli* spp. were enumerated in ileal and cecal contents on d 35, 39 and 42. Nine (6.25%) birds died during the first 4 days of diet shift, but lesions typical of necrotic enteritis were seen in only three of them. There was a significant ($P < 0.05$) increase in the *C. perfringens* and total anaerobes count in cecum, but not in ileum due to guar gum addition. There were no significant effects of protein on the *C. perfringens* numbers except on d 42 in cecum where counts were significantly ($P < 0.05$) higher in birds fed SPC-based diet. Viscosity and the clostridial counts were significantly ($P < 0.05$) correlated in the cecum on d 35, 39 and 42, and in ileum on d 35. There were no significant differences in the *Lactobacilli* and total aerobic counts between different treatment groups. The viscosity and the pH of ileal contents were significantly higher and lower, respectively in birds fed diets with added guar gum. The pH of ileal contents was significantly ($P < 0.05$) higher in SPC-fed birds compared to control and fish meal-fed birds. Hence, it was concluded that the guar gum was associated with increase in *C. perfringens* and total anaerobes but the protein level had little effect on populations of these bacteria.

290 Organic acids improve phytate phosphorus utilization in chicks fed a corn-soybean meal diet. K. A. Rafacz*¹, C. M. Parsons¹, and R. A. Jungk², ¹*University of Illinois, Urbana*, ²*PMP Fermentations Products Inc., Peoria, IL.*

Previous research from our laboratory has shown that citric acid improves phytate phosphorus (P) utilization in chicks fed a P-deficient corn-soybean meal diet. The current study was conducted to determine if other organic acids are effective, with emphasis on gluconic acid. Two experiments were conducted in which four replicate groups of five crossbred chicks (New Hampshire X Columbian) were fed a P-deficient (0.16%) nonphytate P diet from 8-21 days of age. In Experiment 1, a completely randomized design was utilized to evaluate the effects of two levels of sodium gluconate (Na Glu), calcium gluconate (Ca Glu), and glucono-delta-lactone (GDL) and one level of HMB (2-hydroxy-4-methylthio butanoic acid as Alimet[®]). The diets were formulated to contain 1.5% or 3% of the gluconates or 1% HMB. Chick weight gain and tibia ash were significantly increased ($P < 0.05$) by Ca Glu (1.5%), Na Glu (1.5 and 3%), GDL (1.5 and 3%), and HMB (1%). In Experiment 2, a 4x2 factorial design was used to evaluate the effect of 2% of Na Glu, Ca Glu, and citric acid (CA) in two diets containing either 0.16 or 0.45% nonphytate P. All diets were formulated to be isocaloric and equal in Ca, Na, and Cl. Tibia ash was significantly increased ($P < 0.05$) by all three organic acids in chicks fed the 0.16% nonphytate P diet but not in chicks fed the 0.45% nonphytate P diet indicating that the responses were due to increased P utilization. The results of this study show that Na Glu, Ca Glu, GDL, HMB, and CA improve phytate P utilization in chicks fed a corn-soybean meal diet.

Key Words: Organic Acids, Chicks, Phosphorus

291 Phytase and 1 α -OH cholecalciferol (1 α -OH D₃) supplementation to broilers during the starting and growing/finishing phases. J. P. Driver*, G. M. Pesti, R. I. Bakalli, and H. M. Edwards, Jr., *The University of Georgia, Athens.*

There is considerable data in the literature on the efficacy of exogenous phytase supplementation for very young, starting, broiler chickens. However there is limited information on exogenous dietary phytase for growing/finishing broilers older than 21 days. Supplemental 1 α -OH D₃ has been shown to have qualitatively similar and quantitatively additive effects to exogenous phytase supplementation. An experiment was

conducted with 4 replicate pens per treatment of 30 broiler chicks from 0 to 35 days of age in litter covered floor pens. All birds were fed corn, soybean meal and soybean oil based diets and raised in houses which precluded any UV light penetration. From 0 to 18 days the birds were fed a 23% protein diet with 0.6% Ca, 0.5% total P (tP) and 0.24% non-phytate P (nPP). From 19 to 35 days the birds were fed a 19% protein diet with 0.3% Ca, 0.37% tP and 0.14% nPP. Eight replicates were fed a control diet with 0.9% Ca, .71% tP and .45% nPP 0-18 days, and 0.8% Ca, .71% tP and .45% nPP from 18-35 days. A supplement of 1000 FTU Natuphos 5000[®] phytase and 5 μ g/kg 1 α -OH D₃ (P+1A) was supplemented during the starter (0-18 days) or grower/finisher (18-35days) phases. The incidences of rickets and tibial dyschondroplasia were measured at 18 and 35 days. Un-supplemented chicks performed well but had considerable leg problems (1705 g gained and 2.096 g feed/g gain). Chicks fed P+1A during the starter (1886 g and 1.97 g/g) or grower/finisher phases (1733 g and 2.12 g/g) did not perform as well as those fed P+1A throughout (1933 g and 1.92 g/g). Boilers fed P+1A throughout performed as well as the controls (1940 g and 1.92 g/g) without any indication of increased leg problems. It is concluded that properly supplemented diets with as little as 0.3 % Ca and 0.14% nPP may be fed to broilers older than 18 days of age if properly supplemented with exogenous phytase and 1 α -OH D₃.

Key Words: Broiler, Phytase, 1-alpha-OH Cholecalciferol

292 Efficacy of an *Escherichia coli* phytase on growth performance, nutrient utilization and bone characteristics in broiler chicks. E. M. Onyango*¹, M. R. Bedford², and O. Adeola¹, ¹*Purdue University, West Lafayette, IN*, ²*Zymetrics Inc., Marlborough, Wiltshire, UK.*

An *Escherichia coli*-derived phytase was compared to that of a commercially available *Peniophora* phytase in order to evaluate its efficacy in improving growth performance and nutrient utilization of broiler chicks. One hundred and forty four 7-d-old male broiler chicks were grouped by weight into six blocks of six cages with four birds per cage. Six corn-soybean meal-based diets were randomly assigned to cages within each block. The six diets were adequate P and low P diets containing (g P/kg diet) 7.7 and 3.9, respectively; and low P diet plus either the *Escherichia coli*-derived phytase or the *Peniophora* phytase at 500 or 1000 units/kg of feed. The chicks were fed the experimental diets from 8 to 22 d of age. Excreta samples were collected between 17-21 d of age. At the end of the study, chicks were killed and left tibiae removed from the birds. The *Escherichia coli*-derived phytase compared with *Peniophora* phytase was more efficacious in improving weight gain ($P < 0.01$), feed intake ($P < 0.001$), toe ash ($P < 0.05$), tibia ash ($P < 0.001$) and total tract phosphorus retention ($P < 0.001$). There was a linear response to the *Escherichia coli* phytase in weight gain ($P < 0.05$), feed intake ($P < 0.01$), and tibia ash ($P < 0.01$) and phosphorus retention ($P < 0.001$). Both phytase sources improved total tract amino acid retention ($P < 0.05$). The *Peniophora* phytase improved ileal retention of most amino acids ($P < 0.05$). The *Escherichia coli*-derived phytase was efficacious in improving broiler growth performance, bone characteristics, and total tract retention of phosphorus and amino acids.

Key Words: Broiler Chick, *Escherichia coli* Phytase, Nutrient Utilization

293 Dietary Phytates Increase Endogenous Losses in Ducks and Chickens. E. M. Onyango*¹, E. K. Asem², J. S. Sands³, and O. Adeola¹, ¹*Department of Animal Sciences, Purdue University, West Lafayette, IN*, ²*Basic Medical Sciences, Purdue University, West Lafayette, IN*, ³*Danisco Animal Nutrition, Marlborough, Wiltshire, UK.*

The role of different forms of phytate on the regulation of endogenous losses in ducks and chicken was investigated. Forty eight 10-wk-old male ducks or broiler chickens were grouped by weight into eight blocks of 6 cages with one bird per cage. On the first day of experimentation, birds were fed by intubation the following six diets: dextrose alone or dextrose plus either phytic acid, magnesium-potassium-phytate, phytase (1000 U), phytic acid plus phytase, or magnesium-potassium-phytate plus phytase. All excreta were collected continuously during the 54 h following feeding and frozen until analyzed. Excreta were freeze-dried, ground and analyzed for dry matter, and their content of energy, nitrogen, mucin and sialic acid. Ducks fed magnesium-potassium-phytate excreted more nitrogen ($P < 0.05$) than those fed dextrose alone but

the amount excreted was similar to that excreted by ducks fed phytic acid. This however was not true for chickens. The highest amount of crude mucin was excreted by ducks and chickens fed magnesium-potassium-phytate followed by those fed phytic acid ($P < 0.05$). Ducks and chickens fed either phytic acid or magnesium-potassium-phytate excreted higher ($P < 0.05$) amounts of sialic acid than those fed dextrose alone. Addition of phytase to the diets did not reduce the endogenous losses observed in the ducks or chickens. In conclusion, presence of either phytic acid or magnesium-potassium-phytate in diet induces an increase in endogenous losses in ducks and chickens.

Key Words: Chicken, Duck, Endogenous Loss

294 The effect of phytase on performance of broilers fed high and low phytate phosphorus diets. M. Manangi* and C. Coon, *Department of Poultry Science, University of Arkansas, Fayetteville.*

A 42-d broiler experiment was conducted to determine the effect of added microbial phytase (Phyzyme#8482XP 5000G) to low and high phytate phosphorus (P) diets on broiler performance, ileal P retention and % tibia ash. The experiment consisted of 12 treatments with 2 levels of phytate P; 1) low phytate (LP) group-0.24% and 2) high-phytate (HP) group-0.32%. Both LP and HP groups had respective positive controls (PCs) and 5 basal diets with graded levels (0, 250, 500, 750 and 1000 FTUs/kg diet) of added phytase. A total of 1536 one day old male Cobb 500 broiler chicks were allotted to 48 pens with 32 chicks per pen and 4 pens per diet. A significant ($P < 0.001$) phytase effect was found for body weight gain, feed intake, feed: gain ratio, ileal P retention and tibia ash % for both LP and HP groups on day 42. Supplementation of 250 FTUs phytase/kg diet for both LP and HP basal diets produced equivalent body weights ($P > 0.05$) to comparable respective PCs. Supplementing 500 FTUs phytase/kg diet in both LP and HP groups resulted in a comparable ($P > 0.05$) % tibia ash to respective LP and HP positive control groups. The LP basal diet supplemented with 250, 500, 750 and 1000 FTUs phytase/kg diet was fed to broilers from 1-42d. The phytase produced increased body weights of 365, 403, 440 and 240 grams, increased ileal P retention by 9.83, 9.12, 8.17 and 15.76% and increased tibia ash % by 4.29, 6.4, 8.42, and 7.93, respectively. The same phytase supplementation in the HP basal diets increased body weights by 478, 568, 570 and 395 grams, ileal P retention increased by 7.21, 9.93, 10.91 and 20.62% and tibia ash % increased by 4.46, 10.67, 10.12, and 10.79, respectively. Based on body weight gain and % tibia ash, feeding 500 units of phytase/kg diet from 1-42d replaced 0.14% of non-phytate P in both LP and HP diets. An additional increase in body weight, ileal P retention and tibia ash % in the HP supplemented groups compared to LP groups due to increase in phytase levels/kg diet could be attributed to more substrate (phytate P) concentration.

Key Words: Phytase, Phytate P, Ileal P

295 Effects of various phytase concentrations in diets with low-phytate corn on broiler chick performance and metabolizable energy. N. J. Baker*, A. S. Parsons, N. P. Buchanan, and J. S. Moritz, *West Virginia University.*

Research indicates a reduction of phosphorus content in fecal excreta with the supplementation of phytase to corn-soybean based diets or with the use of low phytate corn (LPC) in broilers. This study examined how 0 to 3 wk broiler chicks are impacted by concomitant phytase supplementation with LPC (0.136% phytate P by analysis) in the diet. Various levels of phytase (250, 500, 750, 1000, 2000 FYT/kg) from either 2500 or 5000 FYT/g of dry *Peniophora lycii* phytase product were used as experimental treatments. Efficacy of treatments was determined using a response curve created with monocalcium phosphate providing 0.23%, 0.28%, 0.33%, and 0.38% levels of available phosphorus. All diets that included phytase contained 0.23% available phosphorus, 0.8% calcium and LPC. Following a 6-day pre-test, 576 broiler chicks were randomly assigned to one of the 12 dietary treatments, with 8 replicates and 6 birds per cage. Measurements of live performance, tibia ash, mineral digestibility, and apparent metabolizable energy (AME) were obtained. Increasing phytase concentration led to a linear increase in live weight gain ($P = 0.0309$) and a linear decrease in feed conversion ($P = 0.0010$). At enzyme levels greater than 250 FYT/kg, digestible phosphorus, calcium, and AME increased ($P < 0.05$). The two *Peniophora lycii* products, when used to make similar experimental treatments, did not differ regarding performance, mineral digestibility and AME ($P > 0.05$). Thus,

phytase supplementation in diets containing LPC had a positive impact on broiler chick growth.

Key Words: Broiler Chick, Low Phytate Corn (LPC), Phytase

296 Performance and phosphorus excretion of chicks fed conventional or low-phytate corn-soybean meal diets without or with phytase. E. G. Xavier, G. L. Cromwell*, and M. D. Lindemann, *University of Kentucky, Lexington.*

An experiment was conducted to assess diets containing normal (N) corn and N soybean meal (SBM) or low-phytate (LP) corn and LP, low-oligosaccharide SBM, without or with phytase (Natuphos[®], BASF; 750 units/kg), on performance and excretion of total and soluble P by chicks. The two corns were near-isogenic and the two SBM were from near-isogenic soybeans. They were provided by Pioneer Hi-Bred International. The N-corn, LP-corn, N-SBM and LP-SBM contained 0.25, 0.26, 0.70, and 0.77% total P and 0.05, 0.17, 0.22, and 0.55% non-phytate P. Chicks (3-d-old, 63 g initial weight) were fed 10 diets for 14 d. Diets 1 to 5 were N-corn + N-SBM with 0.75, 0.66, 0.66, 0.57, and 0.57% total P, respectively, with Diets 3 and 5 containing phytase. Diets 6 to 10 were LP-corn + LP-SBM with 0.60, 0.51, 0.51, 0.42, and 0.42% total P, with Diets 8 and 10 containing phytase. Diets 1 and 6 contained the same amount of non-phytate P (0.47%) and similar amounts of bioavailable P (0.45 and 0.43%). Diets were fed to five replications of six chicks/pen in batteries. Daily gain was reduced as dietary P was decreased to the lowest level ($P < 0.05$), and phytase did not overcome the reduction in growth (25.6, 24.7, 24.7, 22.5, 22.7, 26.4, 25.4, 26.0, 23.7, 23.0 g/d for chicks fed Diets 1 to 10, respectively). Tibia strength and ash followed similar patterns (11.2, 9.2, 9.9, 6.3, 7.3, 12.5, 10.5, 11.1, 7.8, 8.0 kg; 41.2, 39.3, 40.7, 35.0, 36.1, 42.2, 40.2, 41.0, 37.3, 37.3%). Daily excretion of total P (112, 100, 95, 87, 80, 58, 48, 45, 40, 34 mg/d) and soluble P (2.9, 1.3, 1.6, 1.0, 1.4, 1.7, 0.8, 0.8, 0.9, 0.7 mg/d) both decreased ($P < 0.05$) as dietary P decreased and the amounts were less ($P < 0.05$) in chicks fed the LP-diets. Inclusion of phytase tended ($P < 0.10$) to decrease total P excretion, but phytase did not affect soluble P excretion ($P > 0.05$). Compared with the conventional diet at the NRC level of non-phytate P (Diet 1), feeding LP-corn and LP-SBM in combination with phytase (Diet 8) reduced total P excretion by 60% and soluble P excretion by 72% without negatively impacting performance or bone traits.

Key Words: Chicks, Phosphorus, Phytase

297 Effects of dietary organic acid and phytase supplementation on performance and calcium and phosphorus utilization in laying hens. M. Sari, A. G. Onol, M. Daskiran*, and O. Cengiz, *Adnan Menderes University Faculty of Veterinary Medicine, Adnan Menderes University, Aydin, Turkey.*

An experiment was conducted to determine the effects of dietary organic acid and phytase supplementation on performance and calcium and phosphorus utilization in laying hens. Two hundred 23-wk-old Brown Nick layers were randomly allocated into 50 cages (42x50 cm) each containing 4 birds. Corn-soybean meal based rations were used. Five dietary treatments were formed as followed: (1) a basal ration with no supplemental P (- control) (2750 kcal ME/kg, 17% CP, 0.34% total P, 3.8% Ca), (2) basal ration supplemented with dicalcium phosphate (1.4%) (+ control), (3) basal ration supplemented with 0.035% phytase (ZY Phytase II-5), (4) basal ration supplemented with 1.0% organic acid (Salstop SD) and (5) basal ration supplemented with both 0.0035% phytase and 1.0% organic acid. Water and feed were provided for ad libitum consumption and a lighting program of 16 h light : 8 h dark was applied throughout the study. Each dietary treatment had 5 replications and each replication comprised two adjacent cages. Basal diet with no supplemental P resulted in body weights that were lower ($P < 0.05$) than those of hens fed diets supplemented with phytase, organic acid, or both. Hens fed diets supplemented with dicalcium phosphate, phytase, and organic acid and phytase had higher egg production ($P < 0.001$) (91.3, 86.1, and 93.7% respectively) compared to hens fed either basal diet (78.5%) or basal diet with organic acid supplementation (78.6%). Additionally, the unsupplemented or organic acid supplemented corn-soybean meal diet had lower feed consumption and higher feed conversion ratio ($P < 0.01$). Hen tibia ash and serum calcium levels were not affected by the dietary treatments whereas diets supplemented with dicalcium phosphate, phytase, and phytase + organic acid had higher ($P < 0.01$) serum inorganic phosphorus. The results of this study indicate that dietary phytase improves P utilization in corn-soybean meal based

diets with no supplemental P and acidification of gastrointestinal tract may further improve this utilization.

Key Words: Organic Acid, Phytase, Laying Hen

298 Effect of a thermo-tolerant phytase on performance and bone ash in broilers fed variable levels of dietary nutrients. C. W. Wyatt*¹, M. R. Bedford¹, T. Parr², and S. Davis², ¹Zymetrics Inc., Golden Valley, MN, ²Colorado Quality Research, Wellington, CO.

Two studies investigated the effect of a thermo-tolerant E.coli-derived phytase (QuantumTM) on performance and bone parameters of broilers fed diets varying in content of available phosphorus (AP), metabolizable energy (ME) and total lysine (TLYS). A 48-day floor pen trial used 80 pens of 16 male broilers fed corn/soya/meat-bone meal based diets formulated to commercial averages (AS) or below. A four phase positive control (PC) diet was fed with .91, .82, .76, .69% calcium (CA) and .45, .39, .34, .30% AP, and two negative control (NC) diets were formulated to contain less AP(.09% or .12%), ME(26 or 45kcal/kg) and TLYS(.01 or .03%), respectively for each phase. 250, 500 or 1000 U phytase/kg diet were supplemented to each NC resulting in 10 treatments. At day 40 and 48, the initial reduction in AP, ME and TLYS did not affect performance, but further nutrient removal reduced performance compared to the PC. Supplementing all NC diets with at least 250U/kg phytase improved performance to equal or better than the PC. Lowering AP significantly reduced 48 day femur ash, but this was restored to equal or better than the PC on adding phytase. A second 50-day floor pen trial using 88 pens of 16 male broilers was conducted to determine the impact of phytase on growth, bone ash and breast yield in corn/soya/meat-bone meal based diets varying in ME. As above, a four phase PC diet was fed and three NC diets were formulated to contain less AP(.12%) and TLYS(.01%) and ME lowered by 30, 45 and 60kcal/kg, respectively. 500 or 1000 U phytase/kg of diet were supplemented to the three NC diets resulting in 8 treatments. At day 40 and 50, reducing the amount of dietary AP, ME and TLYS resulted in significantly poorer BWT and cFCR, but further reduction in ME did not result in additional losses in performance. Adding 500 U/kg and 1000U/kg phytase to the NC equilibrated performance with that of the PC for the 45 and 60kcal reduced diet respectively. In these studies. EC phytase was able to return NC performance to that of the commercial PC, although the level of phytase needed would depend on the reduction in dietary nutrient levels.

Key Words: Broiler Chick, Escherichia Coli Phytase, Performance

299 The influence of an E.coli derived phytase on performance of turkeys fed phosphorus deficient diets. M. R. Bedford* and C. L. Wyatt, Zymetrics Inc., Golden Valley, MN.

The effect of a thermo-tolerant E.coli-derived phytase (Quantum) on performance of turkeys fed phosphorus deficient diets to 84d was investigated. In experiment 1, each treatment consisted of 6 replicates of 15 BUT T8 birds. A positive (PC) and negative control (NC) corn/wheat/soya based ration containing 0.7, 0.5 then 0.5 or 0.35, 0.2 then 0.2% AvP in the starter, grower and finisher was employed. All other nutrients met or exceeded NRC requirements. 0, 100, 300, 900 or 2700 units/kg of an E.coli derived phytase (QuantumTM) was added to the NC to give 6 diets. Performance was monitored at 28, 56 and 84 d of age. At 28 d of age, intake and gain were depressed on feeding the NC but were restored to values equivalent to the PC at 900 units/kg feed.

301 Effect of heat stress on production, reproduction hormone levels, acid-base status, and liver expression of heat shock protein-70 observed in three varieties of laying hens. D. J. Franco*, L. Robeson, and M. M. Beck, University of Nebraska, Lincoln.

Thirty-two hens of each strain (Brown, W98, W36) at 38 weeks of age, were allowed to acclimatize for two weeks at 22C, and then were exposed to heat stress (HS) at 35C for two weeks with two additional weeks at 22C to recover. Production parameters (PP) and mortality rates (MR) were collected for each phase. Reproductive hormone levels (RHL) were obtained from blood collected at each phase. Acid base status (AB), Intestinal calcium uptake rate (CaT), and liver expression of HSP70 data

At 56d of age, intake, gain and FCR deteriorated on feeding the NC, and only on feeding 2700 U/kg was performance restored to PC levels. At 84 days of age, performance on the NC was poorer than the PC and was not restored even on the 2700U/kg treatment. In experiment 2, 11 male Nicholas turkeys were assigned to 6 replicate pens per treatment. There were 5 treatments, a PC, (meeting all NRC requirements) and a NC which contained 0.14% less AvP in each of the 4 phases fed supplemented with 0, 200, 500 or 1250 units of an E.coli derived phytase (Quantum). At 21d the NC performed significantly worse than the PC in terms of FCR only, and this was restored on use of 500 units of phytase or more. By 84 days gain was marginally depressed on feeding the NC and restored on use of even the lowest level of phytase. FCR was unaffected by treatment. Intake tended to drop on feeding the NC and was restored on feeding phytase. These data suggest that the use of moderate levels of phytase can easily compensate for moderate dietary reductions in AvP, but if severe reductions are made, then the subsequent losses in performance are not readily apparent until late on in the growth phase. As a result, short term tests on the bioequivalency of phytase for replacement of inorganic P are likely flawed in their conclusions when applied to full production periods.

Key Words: Phytase, Turkeys, Performance

300 Efficacy of Phyzyme[®] XP phytase in broiler diets containing different levels of calcium and non-phytate phosphorus: performance, bone ash and mineral retention. D. R. Ledoux*¹, J. N. Broomhead¹, and J. S. Sands², ¹University of Missouri, Columbia, ²Danisco Animal Nutrition, Marlborough, Wiltshire, UK.

A six-week floor pen study was conducted to determine the efficacy of Phyzyme[®] XP, in corn-soybean meal-based diets containing different Ca & P levels, on performance, tibia ash, and P retention in broiler chickens. A 3 X 4 factorial arrangement of dietary treatments from hatch to week 3 included 3 Ca & non-phytate P (npP) levels (0.80 & 0.25%, 0.85 & 0.30%, and 0.90 & 0.35%) and 4 levels of Phyzyme[®] XP (0, 250, 500, and 750 U/kg diet). From week 3 to 6, dietary phytase levels were kept the same but Ca & npP levels were reduced (0.70 & 0.15%, 0.75 & 0.20%, and 0.80 & 0.25%). The starter basal diet contained 21.74% CP and 2920 kcal ME/kg, and the grower basal diet contained 19.5% CP and 3010 kcal ME/kg. Six pens of 25 chicks each were assigned to each dietary treatment from day 1 to 42. Significant (P < 0.05) Ca & npP level by phytase interactions were observed for feed intake (FI) at weeks 3 and 6, and for body weight gain (BWG) at week 6. Feed intake, BWG, and FCR were also affected (P < 0.05) by phytase treatment at both weeks 3 and 6, with chicks fed phytase outperforming chicks fed no phytase. Chick performance was not affected (P > 0.05) by Ca & npP at 3 weeks, but were affected (P < 0.05) at 6 weeks, with the best performance observed in chicks fed the 0.90% Ca & 0.35% npP combination. Significant interactive and main effects were observed for tibia ash (%) at 6 weeks, with the response to phytase differing among the Ca & npP levels. Both 3 and 6 week P retention were improved (P < 0.05) by phytase supplementation. Combination of Ca & npP did not affect P retention (P > 0.05) at week 3, but did affect P retention (P < 0.05) at week 6. No Ca & npP by phytase interaction for P retention occurred at either weeks 3 or 6. Results indicate that Phyzyme[®] XP was effective in improving phytate P utilization, and efficacy was influenced by Ca & npP level.

Key Words: Phytase, Mineral Retention, Broilers

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were obtained from samples collected before and during HS exposure. The data for PP and RHL were analyzed using the SAS program 1999 version 8.0 as repeated measure in a 3x3 factorial experiment with a level of significance of 0.05. The data for liver expression of HSP70, AB, and CaT were analyzed in a 3x2 factorial experiment with a level of significance of 0.1. Differences among means were obtained based on LSD test. Brown birds performed least well during subsequent HS, with a higher reduction in egg production and a lower CaT. Most of the PP were reduced in all the birds during HS; however, the highest reduction in egg weight was observed in the W36 hens. AB was characterized by an increase in blood pH and a reduction in PCO₂ during HS. PO₂ showed a small positive increment during HS only for the W36 and HCO₃ levels

were reduced during HS except in W98. HSP70 expression was higher after HS exposure and estrogen was reduced during HS in all strains. Progesterone levels were not affected and LH levels were lower in the W98 birds. In general, the Brown hens fared worst in all parameters measured during HS, while W98 hens performed best; W36 was almost always intermediate. However, Brown birds had higher MR (16%), W36 the lowest (4%) with the W98 (8%) intermediate. Some physiological parameters responded differentially by strain, suggesting that further investigation in gene expression might yield markers that could be incorporated into breeding programs for increasing HS resistance in laying hens.

Key Words: Laying Hens, Heat Stress, Production Parameters

302 Melengestrol acetate (MGA) as an alternative method to induce molting in hens. J. M. Koch^{*1}, J. S. Moritz¹, D. C. Lay Jr.², and M. E. Wilson¹, ¹WVU, WV, ²USDA-LBRU, IN.

Inducing hens to molt increases egg quality, egg production and extends the productive life of hens. Molting is normally accomplished by feed withdrawal, which has received criticism, and alternatives described thus far have resulted in poor post-molt performance. The process of molting leads to cessation of lay, regression of large yellow follicles (LYF) and results in loss of steroidogenic support for the oviduct. MGA, an orally active progestin, may decrease gonadotropic support for the ovary and cessation of lay. Hyline W-36 laying hens (n=104) at 40 wk-of-age were fed either 0 or 8 mg/d MGA for 28 d in a balanced diet and then returned to a normal diet. Four birds on d 0 and 4 birds/treatment on d 1, 2, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40 and 44 were euthanized. The weight (g) of ovary with LYF, magnum, isthmus, shell gland and the length (cm) and weight of the intact oviduct were determined. By d 19, egg production in the MGA treated hens (M) had decreased to 24% where it remained until d 28 compared to 88% in the controls (C). The weight of the ovary with LYF, the oviduct and the magnum decreased ($p < .05$) by day 8 in M compared to C (33 ± 15 vs 62 ± 7 , 39 ± 10 vs 71 ± 1 and 19 ± 6 vs 41 ± 2). Furthermore, oviduct length, isthmus and shell gland weight decreased ($p < .05$) by d 20 in M compared to C (54 ± 7 vs 78 ± 3 , 1.2 ± 0.5 vs 3.3 ± 0.3 and 11 ± 3 vs 23 ± 2). From d 28 to 40, egg production in M increased until similar to C at 83%. Oviduct length, isthmus weight and LYF recrudescence in 3 out of 4 M was similar ($p > .05$) to C by d 32 (59 ± 10 vs 70 ± 3 , 2.0 ± 0.5 vs 2.8 ± 0.4 , 36 ± 12 vs 54 ± 5). By d 36 the shell gland weight in M was similar ($p > .10$) to C and 4 out of 4 hens had recrudescence of LYF (14 ± 2 vs 21 ± 1 , 47 ± 8 vs 40 ± 10); however, it was not until d 40 that the weight of the oviduct and magnum in M was similar ($p > .05$) to C (61 ± 8 vs 64 ± 1 , 33 ± 5 vs 37 ± 1). MGA, when fed to hens in a balanced layer diet, can cause regression of LYF on the ovary, leading to loss of steroidogenic support for the oviduct. Removal of MGA led to recrudescence of LYF, leading to steroidogenic support for the oviduct and return to lay.

Key Words: Hen, Molting, Melengestrol Acetate

303 Incidence of bone breakage of processed White Leghorn hens monitored for skeletal integrity during the second cycle of egg laying. H. Mazzuco^{*1,2} and P. Y. Hester¹, ¹Purdue University, West Lafayette, IN, ²CNPQ, Brasilia-DF, Brazil, ³EMBRAPA Concordia-SC, Brazil.

Hens housed in cages experienced a 29% broken bone incidence after transport and immediately before the water bath stunner (Gregory and Wilkins, 1989, Br. Poult. Sci. 30:555). The current study was carried out to determine the correlation between bone mineral density (BMD) and bone mineral content (BMC) measured in live birds (85 to 125 wk of age) and excised tibia (at 126 wk of age only) with the incidence of broken bones in carcasses of processed 126-wk-old White Leghorn hens. Twenty-seven hens out of a total of 207 White Leghorns of a pedigree line were monitored for BMD and BMC of the tibia and humerus using a dual energy X-ray absorptiometer during a second cycle of egg production. At 126 wk of age, the 207 birds were processed and the bones (femur, tibia, fibula, humerus, radius, ulna, keel, scapula, coracoid, ribs, clavicle, ischium and pubis) were examined for breakage. Values for in vivo BMD and BMC were averaged over the age of the hens and averaged over both bones (humerus and tibia). Correlation coefficients for the incidence of broken bones with the average in vivo BMD during the second cycle of lay and with the excised tibial BMD at 126 wk of age were -0.39 ($P < 0.05$) and -0.54 ($P < 0.01$), respectively. Correlation value for the incidence of broken bones with excised tibia BMC at 126

wk of age was -0.53 ($P < 0.01$) and with the second cycle in vivo BMC was not significant ($r = -0.20$). The percentage of broken bones of the total bones examined per bird at the end of processing at 126 wk of age averaged 34% with a range of 0 to 61%. These results show that BMD monitored in live birds during a second egg laying cycle (85 to 125 wk of age) as well as in the excised tibia at 126 wk of age were negatively and significantly correlated with the incidence of bone breakage in processed carcasses. It is concluded that as BMD decreased in White Leghorns, the incidence of breakage increased.

Key Words: Spent Hens, Bone Mineral Density, Bone Breakage

304 Impact of supplemental L-carnitine in broiler breeder diets on subsequent egg hatchability and progeny embryogenesis. J. P. Tanksley^{*1}, E. D. Peebles¹, M. T. Kidd¹, C. D. McDaniel¹, S. K. Whitmarsh¹, H. M. Parker¹, and P. D. Gerard², ¹Department of Poultry Science, Mississippi State University, Mississippi State, ²Experimental Statistics Unit, Mississippi State University, Mississippi State.

The impact of supplemental L-carnitine in broiler breeder diets on subsequent egg hatchability and progeny embryogenesis were investigated in this study. Beginning at 21 weeks of age, hens were fed diets supplemented with either 0 (control) or 25 ppm L-carnitine (treated) through 40 weeks of age. In each of 16 breeder floor pens, 20 hens were housed, with 8 replicate pens assigned to each of two treatment groups. At 27, 32, and 38 weeks of age 15 eggs from each replicate pen were set at random according to treatment in a single incubator for determination of set egg weight (SEW) and relative embryo (REMW; % of set EW), yolk sac (RYSW; % of set EW), and liver (RLW; % of embryo weight) weights at 18 days of incubation. Similarly, at 25, 30, 32, and 38 weeks of age, approximately 70 eggs from each replicate pen were set in a separate single incubator for determination of hatchability and embryonic mortality. Breeder hen age significantly affected percent hatchability of fertile eggs set, percent early dead mortality, REMW, and RLW, but did not influence percent late or piped embryo mortalities, and RYSW. Dietary treatment did not significantly affect any of the aforementioned parameters except SEW. At Week 27, supplemental carnitine reduced SEW by 3.1 %. In this study, 25 ppm supplemental dietary L-carnitine decreased SEW at 27 wk, but did not impact subsequent egg hatchability and progeny embryogenesis between 25 and 38 weeks of breeder hen age.

Key Words: Broiler breeder, Carnitine, Embryogenesis

305 Chicken sperm motility and metabolism are altered immediately by semen dilution. H. M. Parker^{*} and C. D. McDaniel, Mississippi State University, Mississippi State.

The Sperm Quality Index (SQI) is most predictive of rooster semen quality and fertility when semen is diluted no more than 10-fold prior to analysis. The present study was conducted to determine why the SQI was not as predictive of fertility at higher semen dilutions by examining the effects of semen dilution on sperm motility and metabolism. Semen from 15 roosters was collected, pooled and then diluted with 0.85% saline to achieve sperm concentrations from 30 to 1300 million sperm/mL. For each vial of diluted semen, oxygen and ATP content as well as the SQI and sperm viability were measured within one minute of dilution. To examine motility of individual sperm cells the SQI was expressed as SQI/million sperm. Viability was not affected by semen dilution. As expected, the SQI declined logarithmically with increasing semen dilution or decreasing number of live sperm. However, as semen dilution increased, motility of individual sperm cells was accelerated. Also, no free oxygen was present in the neat semen sample, but the partial pressure of oxygen for the fresh diluent was 218 mmHg. Therefore, as semen was diluted, the oxygen present/sperm increased exponentially resulting in a greater rate of sperm motility ($r^2 = 0.93$). Additionally, as semen was diluted, the sperm utilized more oxygen resulting in a positive correlation ($r = 0.93$) of the SQI/sperm with oxygen utilization. Furthermore, at lower dilutions, ATP present/sperm declined with dilution. This decline was most likely due to the sperms dependence on anaerobic metabolism, because of the lack of oxygen, and the slow increase in sperm motility. However, at higher dilutions ATP/sperm increased rapidly with dilution most likely due to greater available oxygen and aerobic metabolism. Apparently, diluting semen samples alters oxygen utilization, ATP metabolism, and therefore sperm motility. These

changes in sperm metabolism and motility are most likely the reason the SQI is not very predictive of fertility at dilutions greater than 10-fold.

Key Words: Sperm Quality Index, Semen Dilution, Sperm Metabolism

306 Expression of the mRNA for zona pellucida proteins 1 and 3 in two genetic lines of turkey hens that differ in fertility. A. P. Benson^{*1}, A. J. Davis¹, B. D. Fairchild¹, and V. L. Christensen², ¹University of Georgia, Athens, ²North Carolina State University, Raleigh.

The inner perivitelline layer of avian species contains zona pellucida protein-1 (ZP1) and zona pellucida protein-3 (ZP3) and these two proteins may be involved in sperm binding. ZP1 is produced by the liver and transported to the developing follicle, while ZP3 is synthesized and secreted by granulosa cells of the preovulatory follicle. The expression of mRNA for ZP1 and ZP3 was investigated in two lines of turkey hens selected for over 40 generations for either increased egg production (E) or increased body weight (F). Total RNA was extracted from the liver and from 1 cm² sections of the granulosa layer around the germinal disc (GD) or a nongerminal disc (NGD) area of the F₁ and F₂ follicles of six, 48 week-old hens from each genetic line. In order to obtain enough RNA for subsequent Northern analysis, the granulosa samples had to be pooled for two birds for each follicle size (n = 3). Northern analysis for ZP1 and ZP3 was performed using chicken cDNA probes. Equality of RNA loading and transfer was verified with a cDNA probe of chicken GAPDH for ZP1 and with a cDNA probe of mouse 18S ribosomal RNA for ZP3. Hepatic expression of the mRNA for ZP1 tended (P = 0.07) to be greater in turkey hens from the E-line than the F-line. The expression of the mRNA for ZP3 was equal between the two genetic lines of turkeys and within each line between the GD and NGD regions of the F₁ and F₂ follicles. The results suggest that the higher rates of fertility previously observed for eggs from the E-line versus the F-line of turkeys may be related to the higher expression of the potential sperm binding protein ZP1.

Key Words: Zona Pellucida Proteins, Turkeys, mRNA Expression

307 Follicular development and expression of the mRNA for the inhibin/activin subunits in two genetic lines of turkey hens that differ in total egg production. J. B. Hoffman^{*1}, A. P. Benson¹, A. J. Davis¹, B. D. Fairchild¹, and V. L. Christensen², ¹University Of Georgia, Athens, ²North Carolina State University, Raleigh.

Inhibin and activin appear to play key roles in follicular maturation in avian species. The expression of mRNA for the inhibin/activin subunits and the activin binding protein follistatin was investigated in the developing follicles of two lines of turkey hens selected for over 40 generations for either increased egg production (E) or increased body weight (F). Individual bird weights and follicle weights were obtained from six birds of each genetic line at 46 and 58 weeks of age. Total RNA was extracted from individual granulosa layers of the F₁ through F₄ follicles and from the combined theca and granulosa layers of the small yellow follicles (SYF, 5-10 mm) and large white follicles (LWF, 2-5 mm). Chicken cDNA clones were used in the Northern analysis of the inhibin α -subunit, inhibin/activin β_A - and β_B -subunits and follistatin. Average body weight was 3 times greater for the F-line birds, however, total follicular weight relative to body size was significantly less for these hens compared to the E-line hens. Although total follicular weight was less in the F-line hens, the preovulatory hierarchy for these birds contained 5-7 more follicles than the hierarchy for the E-line hens. Furthermore, the total relative mass of both the SYF and LWF was the same for both genetic lines of turkeys, however, the number of these follicles was significantly greater for the F-line hens. Thus, the decrease in total relative follicular mass in the F-line hens results from significantly smaller relative to body weight F₁ through F₄ follicles when compared to the E-line. The inhibin/activin β_B -subunit and follistatin were expressed very strongly in the large white follicles. Expression of the β_A -subunit was limited to the hierarchical follicles. The inhibin α -subunit was expressed in all follicles examined. The lack of a well defined preovulatory follicular size hierarchy in the F-line hens contributes to the decreased production and fertility observed in these birds compared to the E-line hens.

Key Words: Inhibin, Activin, Turkey Hens

308 Progesterone injections induce a polycystic ovarian follicle syndrome (PCOF) in young turkey hens. W. L. Bacon^{*} and H.-K. Liu, *The Ohio State University, Wooster.*

An arrest in laying associated with a PCOF syndrome has been reported in turkey hens photostimulated with constant light. The ovaries of PCOF hens contained a normal number of hierarchical follicles (7 to 10), and 5 or more larger follicles, some of which were cystic. Comparing PCOF hens to laying hens, the oviduct was of equal weight, plasma concentrations of estradiol-17 β (E₂) were equal, luteinizing hormone (LH) slightly lower, and progesterone (P₄) several fold higher. We hypothesized that constant lighting overstimulated the ovary, inducing a high level of P₄ secretion which blocked ovulations but not entrance of follicles into the hierarchy, resulting in the PCOF syndrome. Experiments to examine effects of P₄ injections (0.17 to 1.50 mg kg⁻¹d⁻¹ for 7 to 14 d), duration of egg production (6 to 38 wk), and photoperiod (14L:10D or constant light) on egg production, ovarian follicles, and oviduct weight were conducted. In 6 experiments, hens were necropsied immediately after the last P₄ injection. Egg production was decreased by about 50% with injection of 0.17 mg kg⁻¹d⁻¹, and ceased with injection of 0.33 mg kg⁻¹d⁻¹ or greater. In hens of < 15 week of production ovarian follicle number was slightly increased, oviduct weight was unaffected, and atretic follicle number increased. At 38 wk of production, ovarian follicle number and oviduct weight decreased, and atretic follicle number increased. No hens presented with the PCOF syndrome. Two additional experiments were conducted with young hens, with the hens necropsied 3 wk after last P₄ injections. In these experiments most of the hens given constant lighting and P₄ (0.33 mg kg⁻¹d⁻¹) presented with the PCOF syndrome at necropsy. The PCOF presenting hens had several fold higher P₄ levels at necropsy, slightly lower levels of LH, and normal levels of E₂ in comparison to laying hens. We concluded that P₄ injection for 12 d of hens that had been photostimulated with constant light and were early in the reproductive period could initiate the development of the PCOF syndrome at necropsy 3 wk later.

Key Words: Progesterone, Ovary, Turkey

309 Programming of photorefractoriness: The turkey breeder hen is not like a tree sparrow. J. A. Proudman^{*1} and T. D. Siopes², ¹USDA, ARS, Biotechnology & Germplasm Laboratory, Beltsville, MD, ²Department of Poultry Science, North Carolina State University, Raleigh.

Photostimulation (PS) with a long photoperiod is thought to both initiate egg laying and to program the onset of the photorefractory (PR) response by the presence of thyroid hormone, probably thyroxine (T₄), in the brain during the early weeks following PS. We have conducted three experiments to estimate when programming of the PR response by long days occurs in turkey hens. In Experiment 1, we tested the hypothesis that hormone levels (T₄, T₃, or prolactin) during the first week of lighting may program PR. We retrospectively compared hormone levels at 7, 0, 1, 3, and 7 days from PS of hens that did or did not become PR during 50 wk of lay. Results showed no differences in any hormone considered likely to be involved in programming PR. In Experiments 2 and 3, we attempted to estimate when programming for PR occurs by subjecting hens to long days for differing lengths of time and then returning them to a photoperiod (12L:12D) that is known to support egg production but not induce PR. Each experiment included a long-day control and a control group that would remain photosensitive (constant 12L:12D). All hens were tested for PR by an increase in photoperiod at the end of a lay cycle. Hens that had been programmed for PR should not respond to the increased photoperiod. In Experiment 2, treated hens received 1, 14, or 28 d of 16L:8D followed by 12L:12D until 20 wk of PS. Programming for PR was then assessed by providing 20L:4D for 8 wk. All treatment groups (but not the long day control group) responded to the light change, indicating that programming for PR does not occur within the first 4 wk following PS. In Experiment 3, treated hens received 1, 5, or 9 wk of 18L:6D followed by 12L:12D to 18 wk of PS. We then tested for photosensitivity by restricting light to 8L:16D for 2 wk and then stimulating with 22L:2D for 6 wk. Only 6 of 18 control (18L:6D) hens remained photosensitive at the end of this experiment, while all hens in the 12L:12D control group and all treated hens remained photosensitive. We conclude from these experiments that programming for PR in the commercial turkey hen does not occur within the first 9 wk following photostimulation.

Key Words: Photorefractoriness, Turkey, Photoperiod

310 Photoperiod effects on spontaneous ovarian adenocarcinoma in the domestic turkey breeder hen. C. B. Moore and T. D. Siopes*, *Department of Poultry Science, College of Agriculture & Life Sciences, North Carolina State University, Raleigh.*

The effect of photoperiod or melatonin treatments on ovarian adenocarcinoma in turkey breeder hens was investigated. In Experiment 1, photoperiod effects were tested by exposing turkeys with ovarian tumors to 8 wks of short days (8:16LD) followed by a 12 wk period of long days (16:8LD). In Experiment 2, exogenous melatonin was administered to turkeys during long day-induced development of ovarian tumors. In both experiments, the stage of tumor growth was scored weekly on a subjective scale of 0 to 4. It was clear that exposure to short days produced complete regression of tumors, with a mean time to score 0 of 4.4 wks. Following re-exposure to a long photoperiod, all of the same birds showed re-growth of the ovarian tumor with a mean time to first palpable detection of 5.4 wks. When melatonin was administered daily during the long photoperiod (Experiment 2), there was a significant delay in the re-growth of tumors. It was concluded that the growth of solid ovarian tumors in the turkey breeder hen was promoted by long photoperiods and ceased, to the point of remission, on short photoperiods. Thus, ovarian adenocarcinoma in turkeys can be completely manipulated by photoperiod. In addition, treatment with melatonin attenuates tumor growth in the turkey hen. The results suggest that the domestic turkey hen may be a useful *in vivo* model for studying spontaneous ovarian adenocarcinoma.

Key Words: Cancer, Photoperiod, Ovary

311 The distribution and change in the number of gonadotropin-releasing hormone neurons in chicks following an increase in photoperiod plus administration of sulfamethazine. W. J. Kuenzel* and C. D. Golden, *University of Arkansas, Fayetteville.*

Gonadotropin-releasing hormone-1 (GnRH-1) neurons are well known to be critical for the regulation of gonadal development due to their stimulation of luteinizing hormone and follicle stimulating hormone release from the adenohypophysis. One consistent finding for GnRH-1 neurons is that their cell number remains relatively stable over the life cycle of a particular avian species. In addition, many studies have suggested that the principle location of GnRH neurons occurs in the medial preoptic hypothalamic region. A study was designed to determine whether significant increases in GnRH-1 neurons could be induced after treatment with a compound, sulfamethazine (SMZ), known to stimulate early sexual maturation. A two-by-two factorial [two diets (SMZ and control) and two photoperiods (shortday, LD8:16 and longday, LD16:8)] experiment was designed to determine whether photoperiod and/or SMZ could alter the number of GnRH neurons in male chicks. A set of sections extending from the septopallio-mesencephalic tract (TSM) to the end of the septal region was completed for each bird (n=5/treatment). Results showed that regarding the distribution of GnRH neurons, a low percentage were actually found to occupy the preoptic, hypothalamic region. In

contrast, the vast majority of the neurons (75%) occurred in the subpallial brain region while the remainder was partitioned among three subgroups found in the diencephalon. No significant changes were noted in total GnRH-1 neurons among the four treatment groups, however, in one of the largest sub-groupings of GnRH neurons, the bed nucleus of the pallial commissure (NCPa), a significantly larger number of neurons were found in long-day SMZ fed birds compared to chicks raised in a short photoperiod (LD8:16) and fed a standard ration. Results suggest the importance of the NCPa, located in the subpallial region, as containing GnRH neurons that appear most responsive to manipulations of photoperiod in birds. Supported in part by NSF Grant # IBN-0315793 to W.J.K.

Key Words: GnRH, Subpallium, Reproduction

312 Changes in eggshell of Japanese quail during embryogenesis. S. Westmoreland*¹, P. Hester², and T. Halupnik¹, ¹*The University of Texas at Arlington, Arlington,* ²*Department of Animal Science, Purdue University, West Lafayette, IN.*

The avian eggshell is a source of calcium for the developing embryo. Movement of calcium from the shell to the embryo occurs once the chorioallantois is in place and functional. At the blunt end of the egg the chorioallantois has no contact with the shell due to the airspace and no calcium loss occurs. The purpose of the current study was to investigate changes that occur in shells of fertile Japanese quail eggs during incubation in order to have a baseline study for comparison to eggs that were incubated at the MIR space station. It was hypothesized that when eggs reached the stage at which the chorioallantois was in place, shell samples from the equator region (largest shell diameter) would show signs of calcium loss and reduced shell thickness, while samples from the airspace would not. Fertile Japanese quail eggs were collected from a breeding colony at Purdue University. Incubation of the eggs was interrupted at six different intervals: 3, 7, 10, 12, 14, and 16 days. Eggshells were shipped to The Center for Electron Microscopy at The University of Texas at Arlington for analysis. Shells of three eggs for each incubation date were sampled in two regions, the airspace and equator. From each region five radial samples and one inner shell surface sample were prepared for viewing on the scanning electron microscope. Digital micrographs were taken to document shell changes. Measurements were collected of shell thickness for each radial sample. No changes were observed in shell samples from either airspace or equator in eggs incubated 12 days or less. In eggs incubated 14 or 16 days voids were seen in the mammillary cones of equator samples; no voids were found in airspace samples. For any given day of incubation, the equator region shell samples were consistently and significantly thicker than airspace samples. In eggs that had been incubated 14 and 16 days, the equator samples approached the thickness of the airspace samples. This trend is interpreted to indicate that shells are normally thicker at the equator than the airspace region, but the relative shell thickness changes at day 14 of incubation when the equator region becomes thinner due to calcium loss.

Key Words: Japanese Quail, Eggshell, Embryogenesis

PSA-Processing & Products: Microbiology & Egg Quality

313 Bacterial load of the crop of turkeys offered a feed supplement during preslaughter feed withdrawal. B. M. Rathgeber*¹, M. E. MacKenzie¹, and J. L. Maclsaac², ¹*Nova Scotia Agricultural College, Nova Scotia, Canada,* ²*Atlantic Poultry Research Institute.*

Normally, feed is withdrawn from broiler turkeys several hours prior to the initiation of catching and shipping, allowing contents of the gut to pass through. This reduces the chance of bacterial contamination due to gut breakage during the evisceration process. During the starvation period there is an increased incidence of litter consumption increasing the bacterial load of the upper digestive tract. The objective of this study was to evaluate the use of a highly digestible supplement during preslaughter feed withdrawal as a means to reduce litter consumption and the bacterial load in the crop of turkeys. For each of two trials 480 female turkeys were grown in 8 pens (60/pen) at a density of 0.18m² / bird. At 9 weeks of age 80 birds from half of the pens were shipped for processing (20 birds/pen). At 10 weeks of age 40 birds from the other four pens were shipped (10 birds/pen). Commercial feed was withdrawn

6 h prior to catching from each pen. A highly digestible nutritive supplement was offered in half of the pens for 5 h in duration. Water only was provided for the last hour before shipping. All birds were slaughtered 9 h after conventional feed was withdrawn. At 9 weeks, after feather removal the crops of 5 birds/pen were removed, placed in sterile bags and placed on ice. At 10 weeks 3 crops per pen were sampled. The number of aerobic bacteria as well as E. Coli, coliformes and salmonella were determined for each crop sampled. There was no difference between the numbers of bacteria in these groups for crops at 9 weeks old compared to 10 weeks. Salmonella was not found in any of the crops in these trials. The total number of aerobic bacteria in the crop was not influenced by the use of the nutritive supplement. Both E. coli and total coliformes were reduced in crops from birds offered the nutritive supplement prior to slaughter (p<0.01). This reduction was more than one log for each of these two categories. The results of this project indicate that populations of bacteria in crop of commercial turkeys can be re-

duced through administration of a highly digestible supplement during the normal preslaughter feed withdrawal period.

Key Words: Feed Withdrawal, Bacteria, Crop

314 Effect of a commercial inside-outside bird washer (IOBW) on *Campylobacter*, *Salmonella*, *E. coli*, and aerobic plate counts (APC) of uncontaminated, contaminated, and cross-contaminated broiler carcasses. D. P. Smith*, J. K. Northcutt, and M. T. Musgrove, *USDA, ARS, Russell Research Center, Athens, GA.*

Processors are washing carcasses with one or more in-line inside-outside bird washers (IOBW) due to zero fecal tolerance regulations. This study was conducted to determine the effect of an IOBW on *Campylobacter*, *Salmonella*, *E. coli*, and aerobic plate counts (APC) of uncontaminated (control), contaminated, and cross-contaminated broiler carcasses at two different IOBW water pressure settings. Three trials of 12 commercially processed carcasses each (two replications of six birds) were conducted as follows: two control carcasses, two carcasses contaminated with cecal contents (inoculated with *Campylobacter* and *Salmonella*) and allowed to dry on carcass skin for 12 min, and two carcasses uncontaminated and placed adjacent to contaminated birds during washing (to determine cross contamination) were prepared (n=36). Whole carcass rinses were conducted on each carcass prior to contamination or washing, then repeated after washing. Carcasses were washed with an in-line commercial IOBW set at 160 bpm (5 s) and either 40 or 80 PSI water pressure. There were no significant effects (P<0.05) from contamination with feces or from cross contamination, nor from IOBW pressure on any microbiological counts. The overall effect of washing was a slight (but not biologically) significant reduction in *E. coli* (3.2 to 3.0) and APC (4.9 to 4.8) log₁₀cfu/ml rinsate. The IOBW decreased the incidence of *Campylobacter* from 14/36 positive carcasses to 1/36 positives, but *Salmonella* incidence for contaminated carcasses increased from 0/12 to 3/12 after washing. The IOBW removed carcass contamination to levels equivalent with control levels without cross contaminating other carcasses. The incidence of *Campylobacter* was decreased, though *Salmonella* was not reduced.

Key Words: Inside-Outside Bird Washer, Fecal Contamination, Broiler Carcass

315 Effects of spray washing with various chlorine levels and water temperatures on skin color and microbiology of broiler carcasses. J. K. Northcutt*, D. P. Smith, M. T. Musgrove, K. D. Ingram, and A. Hinton, Jr., *USDA, Agricultural Research Service, Russell Research Center, Athens, GA.*

A study was conducted to investigate the effects of chlorinated (sodium hypochlorite) spray washing using various water temperatures on breast skin color and microbiology of broiler carcasses. The experiment was a 2 x 3 randomized block design using 0 or 50 ppm added chlorine in tap water at a temperature of 21, 43 or 54°C. Breast skin color was measured and carcasses were subjected to a whole carcass rinse (WCR) before washing (Pre-treatment). Broiler cecal contents (4.95 g) were inoculated with a co-suspension (0.1 mL) containing 10⁷ cells of *Campylobacter* and nalidixic acid resistant *Salmonella*, and 0.1 g were applied to each carcass. Inoculated carcasses were held at room temperature for 12 min before washing in a cabinet washer (80 psi for 5 sec). Immediately after washing, carcasses were subjected to a WCR, and breast skin color was measured again (Post-treatment). Tap water pH ranged from 7.2 to 7.6, and contained an average of 0.5 ppm free chlorine. After the addition of 50 ppm chlorine, water pH increased to 8.2 to 8.4. Washing temperature and additional chlorine had no effect on the breast skin color, with average values of L* = 66.6; a* = -0.09; b* = -0.05. Moreover, washing temperature and additional chlorine had no effect on total aerobic bacteria, *E. coli*, and *Campylobacter* levels on carcasses. Pre- and Post-treatment counts were found to be 4.6, 3.6, and 3.5 log₁₀ cfu/mL rinse for total aerobic bacteria, *E. coli*, and *Campylobacter*, respectively. No nalidixic acid resistant *Salmonella* were found on Pre-treatment carcasses, and average Post-treatment levels were 3.1 log₁₀ cfu/mL rinse irrespective of treatment. Under the conditions outlined in the present study, chlorine level and water temperature had no effect on skin color or broiler carcass microbiology.

Key Words: Inside-Outside Bird Washer, Chlorine, Carcass Contamination

316 Enrichment pH impact on salmonellae recovery from TSP-treated broiler carcasses. D. V. Bourassa*^{1,2}, R. J. Buhr², D. L. Fletcher¹, M. E. Berrang², and J. A. Cason², ¹*University of Georgia, Athens,* ²*USDA-ARS Russell Research Center, Athens, GA.*

Trisodium phosphate (TSP) has been reported to reduce the recovery of salmonellae from processed poultry carcasses. It has been suggested that the high pH of TSP solutions as well as the detergent-like properties are responsible for the reduction in salmonellae recovery. This project was conducted to determine the efficacy of TSP and modified enrichment pH on the recovery of salmonellae. Carcasses were obtained from a commercial processing plant immediately after the final inside-outside carcass washer prior to chilling. Carcasses were subjected to one of four treatment groups; 1) TSP and neutral-peptone (pH 7.0), 2) TSP and acidified-peptone (pH 5.5), 3) no TSP and alkali-peptone (pH 8.5), 4) no TSP and neutral-peptone. Carcasses were individually placed into plastic bags, 500 mL of the pH adjusted peptone was added, the carcasses shaken for 1 min, and pre-incubation pH measured. Carcasses with rinse solution were incubated at 37 C for 24 h and presence of salmonellae determined. The pH of the pre-incubation enrichment peptone was 8.4 for the TSP neutral-peptone, 7.2 for the TSP acidified-peptone, 8.7 for the no TSP alkali-peptone, and 7.1 for the no TSP neutral-peptone. Salmonellae were detected from 50% of the TSP neutral-peptone carcasses, 50% of the TSP acidified-peptone carcasses, 63% of the no TSP alkali-peptone carcasses, and 43% of the no TSP neutral-peptone carcasses.

Key Words: Trisodium Phosphate, Salmonellae, pH

317 Recovery of bacteria from broiler carcasses rinsed 0 or 24 hours after chilling. J. A. Cason*, M. E. Berrang, and D. P. Smith, *Russell Research Center, Athens, GA.*

The PR/HACCP rule for poultry processing requires that selected carcasses be tested for numbers of *E. coli* or presence of *Salmonella* in carcass rinse samples taken immediately after chilling. The results are compared against microbiological standards or criteria based on the 1996 broiler chicken baseline data, but carcasses in that study were shipped to a lab and were rinsed the following day. To test whether carcass rinses done immediately after chilling are comparable to rinses 24 h after chilling, 20 whole broiler carcasses exiting the chiller of a poultry plant were sampled on 3 days. Carcasses were bagged aseptically and rinsed for 1 min in 400 ml of sterile water. Recovered rinse liquid was poured into a sterile container, rinsed carcasses were placed in clean plastic bags, and all materials were held overnight at 4 C. On the following day all carcasses were rinsed again in 400 ml of sterile water as before, and all rinse samples were cultured by standard methods to enumerate coliforms, *E. coli*, and *Campylobacter*, and to determine incidence of *Salmonella*. Statistical analysis used paired comparisons between the same carcasses rinsed at 0 or 24 h after chilling, with numbers of bacteria expressed as log cfu/ml of rinse. Significantly higher numbers of coliforms (3.0 versus 2.7) and *E. coli* (2.7 versus 2.4) were found in the rinse samples taken immediately after chilling versus rinse samples done at 24 h. There were no differences in numbers of *Campylobacter* (mean 1.8) or incidence of *Salmonella* between rinses taken at 0 or 24 hours. More study is required to determine whether rinse sampling of carcasses done at 0 and 24 h after chilling are microbiologically equivalent.

Key Words: Carcass Rinse, Coliforms, *E. coli*

318 Comparison of plate media for direct enumeration of *Campylobacter* spp. from carcasses rinses. K. S. Macklin*, R. S. Miller, and O. A. Oyarzabal, *Auburn University, Auburn, AL.*

Six plate media, Campy-Cefex (CC), modified Campy-Cefex (mCC), Campy-FDA (CF), charcoal cefoperazone deoxycholate agar (CCDA), Campy-Line (CL), and Karmali agar (K) were compared for their effectiveness in isolating *Campylobacter* spp. from commercial broiler carcass rinses. The modifications in mCC were as follows, the replacement of cyclohexamide with amphotericin B and the use of locally available whole lysed horse blood instead of commercially obtained laked horse blood. Carcass rinses were taken post-chill from four different processing plants (A, B, C, D), with 20 carcass rinses collected per plant visit. A standard rinse technique with 400 ml of buffered peptone water and one minute shaking was used for all samples collected. For each sample and each plate type, two 0.10-ml spread plates and four 0.25-ml spread plates were made. Plates were incubated at 42C under microaerophilic

conditions for 48 h. Suspect colonies were counted, examined under phase contrast microscopy and confirmed with a multiplex PCR for differentiation of *C. jejuni*/*C. coli*. The mean log CFU/ml count for each plate medium and for each plant was analyzed using GLM ($P < 0.05$), and means analyzed for differences with Tukey's. Preliminary results from two visits to each plant indicate that the total number of positive plates for five of the media ranges between 41.3 to 48.8%; however the number was significantly lower for CL (28.1%). Mean log CFU/ml for the same five media as above were also similar (0.61 to 0.77), but again counts were significantly lower for CL (0.35). It appears that the composition of CL makes the medium too selective for isolation of low-temperature-stressed *Campylobacter*. The average percent positive for each plant was: A 95%, B 80 %, C 50% and D 0.5%. Mean log CFU/ml for each plant was: A 0.82, B 0.95, C 0.82 and D 0.01. More samples will be collected to determine if the low count and incidence of *Campylobacter* spp. in plant D remains consistent.

Key Words: *Campylobacter* spp., Media, Processing

319 Transfer of *Salmonella* and *Campylobacter* from stainless steel to a ready-to-eat food. C. M. Moore¹, B. W. Sheldon*², and L. Jaykus¹, ¹Department of Poultry Science, North Carolina State University, Raleigh, ²Department of Food Science, North Carolina State University, Raleigh.

The degree of transfer of *Campylobacter jejuni* and *Salmonella enterica* serovar. Typhimurium was evaluated from a stainless steel contact surface to a ready-to-eat food (RTE, lettuce). Stainless steel coupons (25 cm²) were inoculated with a 20 μ l drop of either *C. jejuni* or *S. Typhimurium* to provide an inoculum level of ca10⁶ CFU per 28mm². Wet and dry lettuce (*Lactuca sativa* var. *longifolia*) pieces (9 cm²) were placed onto the inoculated stainless steel surface for 10 s after the designated inoculum drying time (0 to 80 min for *C. jejuni*; 0 to 120 min for *S. Typhimurium*), which was followed by recovery and enumeration of transferred pathogens (lettuce) and residual surface pathogens (stainless steel coupons). For transfers of *S. Typhimurium* to dry lettuce, there was an increase from 36% to 66% in the percent transfer of the initial inoculum load over the first 60 min of sampling followed by a precipitous drop from 66% to 6% in percent transfer. The transfer of *S. Typhimurium* to wet lettuce ranged from 23 to 31%, with no statistically significant difference between recoveries over the entire 120 min sampling period. For *C. jejuni*, the mean percent transfer ranged between 16 to 38% for dry lettuce and 15 to 27% for wet lettuce during the 80-min sampling period. The results of this study indicate that relatively high numbers of bacteria may be transferred to RTE foods such as poultry and red meat products even 1 to 2 hours after surface contamination. These findings can be used to support future projects aimed at estimating the degree of risk associated with poor handling practices of RTE foods.

Key Words: Ready-to-Eat Foods, Cross-Contamination, Foodborne Pathogens

320 Effect of packaging and electron beam irradiation on poultry safety and quality during extended storage. T. M. Preder*, S. J. Lewis, A. Velasquez, and S. R. McKee, Auburn University, Auburn, AL.

Electron beam irradiation (EB) combined with packaging was investigated as a means of extending the shelf-life of skinless, boneless chicken breast fillets (n=240 packages) stored at 4 C. Fillets were subjected to EB dose of 0.8 kGy and stored under aerobic or vacuum-packaged conditions for up to 42 days at 4 C. Weekly up to day 42, 5 packages of breast fillets (4 fillets per package) were randomly selected from each treatment group and subjected to microbial and sensory analyses. At day 0, EB completely eliminated coliforms and generic *E. coli* as well as *Salmonella* and *Campylobacter*. During storage, coliforms increased in non-EB fillets, but generic *E. coli* began to decline in non-EB fillets by day 21 of storage. Psychrotrophs and total aerobic bacteria were not completely eliminated by EB, but levels were lower ($P \#8804 0.05$) in EB samples when compared to non-EB samples. As fillet storage time increased, psychrotroph and aerobic bacteria levels increased in both non-EB and EB fillets. However, increases in population counts for EB fillets were lower ($P < 0.05$) when compared to non-EB. Color determination indicated that EB fillets had higher "a" values when compared to non-EB fillets. As storage time increased, aerobically packaged non-EB fillets had higher "a" values than EB fillets. Consumer taste panels

were conducted up to 42 days for EB fillets, but non-EB fillets were only tested up to 14 days because of high microbial levels. Results suggested that EB did not affect the appearance, flavor, or overall acceptability of fillets compared to non-EB fillets. Overall, the shelf-life in the irradiated fillets was three times higher when compared to the non-irradiated fillets.

Key Words: Electron Beam Irradiation, Shelf-Life, Vacuum-Packaging

321 The relationships among measures of albumen height, pH, and whipping volume. F. G. Silversides*^{1,2} and K. L. Budgell³, ¹Pacific Agri-Food Research Centre, Agassiz, British Columbia, Canada, ²Crops and Livestock Research Centre, ³Nova Scotia Agricultural College.

Defining quality has posed difficulties for the egg industry and measures of albumen height have been used extensively because albumen height is easily measured and decreases with time in storage. The association between albumen height and functional characteristics of the albumen is less clear. A total of 2,123 eggs were obtained from Brown Leghorn, unselected since 1965, ISA-Brown, a commercial brown egg layer, and Babcock B300, a commercial white egg layer, hens at 32, 50, and 68 weeks of age and used to investigate relationships among measures of albumen quality and a functional property of albumen. The eggs were sampled fresh and after storage for five and 10 days. At sampling, eggs were weighed and broken, and albumen height, pH, and volume after whipping for 80 seconds were measured. The yolks and dried shells were weighed, and albumen weight was determined by difference. Egg weight and the weights of the albumen and yolk increased with increasing age of the hen, with yolk weights increasing proportionately more. With storage, egg and albumen weights decreased, while yolk weight increased. Eggs from Brown Leghorn hens were smallest, but had proportionately the largest yolks. Albumen height decreased with time in storage and albumen pH and whipping volume both increased. Differences between lines suggested that commercial selection has changed the proportion of the yolk, albumen, and shell, and increased the albumen height. Albumen height and whipping volume were negatively correlated ($r = -0.29$), and differences between lines (whipping volume of albumen from Brown Leghorn eggs was greater than that of the other two lines) suggest that selection for increased albumen height could have decreased the foaming ability of albumen, which is a principal reason for including eggs in many processed food products.

Key Words: Albumen Quality, Layer Strain, Egg Storage

322 National Egg Temperature Survey: 3. Transport. K. E. Anderson*¹, P. H. Patterson², K. W. Koelkebeck³, M. J. Darre⁴, J. B. Carey⁵, D. U. Ahn⁶, R. A. Ernst⁷, D. R. Kuney⁸, and D. R. Jones⁹, ¹North Carolina State University, Raleigh, ²Penn State University, University Park, ³University of Illinois, Urbana, ⁴University of Connecticut, Storrs, ⁵Texas A&M University, College Station, ⁶Iowa State University, Ames, ⁷University of California, Davis, ⁸University of California, Riverside, ⁹USDA-ARS, Athens, GA.

The Egg Safety Action Plan, raised many questions concerning egg temperature patterns used in the risk assessment model. Therefore, a national study was initiated to determine the extent of egg temperature changes from oviposition through distribution. Researchers composed of Extension Specialists and USDA-ARS, in CA, CT, GA, IA, IL, NC, TX, and PA gathered data on internal and external egg temperatures from commercial egg production, processing, and distribution facilities. The main effects were: geographic region, season, and type of operation. Transport data were recorded from lots of eggs from the processor to the point of resale or distribution. Comparisons between long and short hauls, and seasons were evaluated and geographic region was eliminated due to the movement between regions. A mixed model design was used; random effect of season, and the fixed effect for the transport duration (long or short haul). Information on the use of refrigerated transport trailers as short-term storage was evaluated. Egg temperature was not reduced during short term storage. The decrease in egg temperature was smaller ($P < 0.0001$) during short hauls 0.6 C than during long hauls 7.8 C. There was a significant season by haul interaction ($P < 0.01$) for internal egg temperatures. In the winter, egg temperatures during long and short deliveries were very similar at 10.5 and 13.4C compared to summer when egg temperatures were 11.0 and 22.7 C, respectively. Mean egg temperatures declined during transport similarly during the summer and winter and the temperature differential between

ambient and egg temperatures was only 0.4 C from the start to the end of the delivery. Refrigerated trailers used for short-term storage should be critically evaluated since egg temperatures are not appreciably reduced during this time period. These data suggest that the season of year affects the temperature of eggs during transport and are appreciably cooled on the truck, during the delivery phase. This should be a component in future assessments of egg safety.

Key Words: Egg transport, Egg temperatures, Shell eggs

323 Impact of commercial processing on the microbiological safety and quality of shell eggs. M. T. Musgrove^{1,2}, D. R. Jones¹, J. K. Northcutt¹, M. A. Harrison², and N. A. Cox¹, ¹USDA-ARS, ²University of Georgia, Athens.

Egg shell microbiology has been studied extensively over the years though little of it describes how modern U.S. processing conditions impact bacterial populations. As food safety regulations (e.g., sanitation/HACCP) are being drafted for the industry, such information can be important in determining processing steps most critical to product safety. Five different shell egg surface populations (aerobic, yeasts/molds, *Enterobacteriaceae*, *E. coli*, and *Salmonella* spp.) were monitored at 12 points along the processing line (accumulator, pre-wash rinse, washer one and two, sanitizing rinse, dryer, oiler, scales, re-wash belt entrance and exit, and two packer lanes). Three commercial in-line facilities were visited 3 times allowing for the sampling of 990 eggs that subsequently yielded 5,220 microbial samples. Variations existed in levels recovered from plant to plant but the patterns of fluctuations were similar for each population. Aerobes, yeasts/molds, *Enterobacteriaceae*, and *E. coli* populations were reduced by 30%, 40%, 75% and 50%, respectively, by the end of processing. Log₁₀ counts/ml rinse on eggs collected from packer lanes were decreased by 3.2, 0.8, 1.4, and 0.5, respectively, when compared to rinses from eggs collected at the accumulator. *Salmonella* were recovered from 0 to 48% of pooled samples in the nine replications. More *Salmonella* were recovered from pre-processed (accumulator, pre-wash, re-wash belts) than in-process (washers, sanitizing rinse, dryer, oiler) or ready to pack eggs (scales, packing lanes). These data demonstrate that current commercial practices decrease microbial contamination of egg shell surfaces.

Key Words: Shell Eggs, Processing, Bacteria

324 Identification of *Enterobacteriaceae* and related organisms from rinses of eggs collected during processing in commercial shell egg processing plants in the southeastern United States. M. T. Musgrove^{1,2}, D. R. Jones¹, J. K. Northcutt¹, N. A. Cox¹, and M. A. Harrison², ¹USDA-ARS, ²University of Georgia, Athens.

Shell egg processing guidelines have been established to ensure that external and internal egg characteristics are of suitable quality. However, less is known about shell egg safety. To determine which enteric bacteria enter egg packing plants and persist through processing, eggs were collected from 3 commercial shell egg in-line processing plants on 3 separate visits. During each plant visit, 12 eggs were collected from each of 12 sites along the processing line: accumulator, pre-rinse, 1st and 2nd washer, sanitizing rinse, blower, oiler, check detection/scales, 2 egg packer lanes, re-wash belt entrance and exit. Each egg was sampled by a rinse technique and rinsate was plated onto violet red bile glucose agar with overlay for the detection and enumeration of *Enterobacteriaceae*. From each positive plate, up to 5 colonies were randomly selected and isolated for further analysis. Using biochemical tests, isolates were identified to genus or species. Sites for which the greatest numbers of isolates were identified were those collected from eggs during pre-processing. Sites yielding the least number of isolates were those during or at the end of processing. *Escherichia coli* and *Enterobacter* spp. were isolated from all of the nine plant visits. Other genera isolated from at least one of the three plants included *Cedecea*, *Citrobacter*, *Erwinia*, *Hafnia*, *Klebsiella*, *Kluyvera*, *Leclercia*, *Morganella*, *Proteus*, *Providencia*, *Rahnella*, *Salmonella*, and *Serratia*. Non-*Enterobacteriaceae* isolated and identified included *Aeromonas*, *Chryseomonas*, *Listonella*, *Pseudomonas*, *Sphingobacterium*, *Vibrio*, and *Xanthomonas*. All genera and species were recovered less frequently from processed eggs than from unwashed or in-process eggs. These data indicate that shell egg

enteric bacteria are reduced as a result of commercial processing procedures currently being used.

Key Words: Shell Eggs, Processing, Enterobacteriaceae

325 Specific activity and stability of β -n-acetylglucosaminidase and lysozyme in extracted egg shell membranes as influenced by layer breed and storage variables. G. J. Ahlborn* and B. W. Sheldon, North Carolina State University, Raleigh.

In past studies, eggshell membrane (ESM) bound enzymes (lysozyme and β -N-acetylglucosaminidase, BNAG) or other components successfully reduced the thermal resistance of bacterial pathogens (83-87% reduction in D-values for *S. Typhimurium*, *S. Enteritidis*, and *E. coli* O157:H7). The ESMs are readily extractable and might be used as "natural" processing adjuvants for reducing bacterial heat resistance in foods or pharmaceuticals. Our objective was to investigate how layer breed, age, and processing methods affected ESM enzyme activity over time. Fifty eggs each from White Leghorn (WL) and Rhode Island Red (RIR) layers were washed, emptied, and rinsed. Membranes were carefully removed and twenty 4.7 mm dia. samples cut from each egg. Pooled samples were treated as follows: storage at 4°C, at -20°C, lyophilized, or dried at ambient temperature (ca23°C for 72 h) or at 50°C for 36 h in a convection oven. Samples were stored in airtight containers and enzymatic activity determined at 24 h post processing and after 1, 2, 4 and 6 months. Colorimetric change of 4-nitrophenyl N-acetyl- β -D-glucosaminide was used to evaluate BNAG activity and change in OD at 450 nm with *Micrococcus lysodeikticus* was used to evaluate lysozyme activity. After 24 h, BNAG activity was greatest in frozen samples. Fresh, refrigerated, and freeze-dried ESM exhibited slightly lower but similar activities. Both air and oven drying yielded significant reductions in activity (22 and 34% respectively) but remained constant thereafter. During extended storage (1 to 6 mo), the freeze-dried samples had no significant reduction in activity, while the frozen samples had a 20% loss after 6 mo. Fresh samples quickly degraded and were spoiled after two months. Lysozyme activities were similar to BNAG. Moreover, eggs from WL had up to 20% more enzymatic activity than those from RIR layers. These findings will be useful in further assessing the potential value of and applications for using ESM.

Key Words: Eggshell Membrane, Beta-N-Acetylglucosaminidase, Lysozyme

326 The effect of layer age, storage and strain of hen on egg quality during summer season under Sohag conditions. T. El-Sheikh*, Faculty of Agriculture, South Valley University, Sohag, Egypt.

A total of 600 eggs from 32 and 60 week old Hy-line-White, Hy-Line-Brown and Fayoumi hens were used after lay and after periods of storage of 0, 3, 6, 9 and 12 d at room temperature (30.2°C). Eggs were individually weighed. The yolk of each egg was cautiously separated from albumen and dried. Albumen weight was calculated by difference. Shell thickness was measured using a shell thickness gauge at three different locations on the egg shell. Albumen height was measured using a micrometer. Longer periods of storage resulted in significantly (P<0.05) lower albumen weight (64.28, 63.55, 62.69, 61.94, and 61.62 % for 0 to 12 d of storage) and albumen height (9.46, 8.10, 6.69, 5.45, and 4.58, for 0 to 12 d of storage) and higher albumen pH (7.35, 8.49, 9.10, 9.35, and 9.47, for 0 to 12 d of storage) across the two age groups. Eggs from Hy-line-Brown hens had more albumen and shell than those from Hy-line-White and Fayomi hens. The lower albumen weight and height with increased days of storage were not as pronounced in Fayoumi eggs compared to Hy-line-White and Hy-Line-Brown. Within each line and storage period, the egg weight was more closely associated with albumen weight than with yolk or shell weight. The albumen height of eggs from Hy-line-White hens was lower than those of Hy-line-Brown and Fayomi hens at all storage times, but the albumen pH was higher in either Hy-line-White and Hy-line-Brown compared to Fayoumi. The loss in weight from shell, albumen and yolk was increased with age. The changes in egg composition with storage time and age were solely the consequence of weight loss from the albumen.

Key Words: Fayoumi, Egg Quality, Egg Components

Ruminant Nutrition: Beef - Feedstuffs

327 Effect of pasteurization of potato slurry in corn or barley finishing diets for beef cattle. J. I. Szasz*¹, C. W. Hunt¹, O. A. Turgeon², and P. A. Szasz*¹, ¹University of Idaho, Moscow, ²Koers-Turgeon Consulting Service, Inc., Amarillo, TX.

Pasteurization of vegetable byproducts, such as potato slurry (PS), may be necessary to prevent spread of pathogens and beef carcass blemishes. We hypothesized pasteurization would increase ruminal fermentability of PS. Four ruminally cannulated crossbred beef steers were used in a 4 x 4 Latin square experiment with a 2 x 2 factorial arrangement of treatments to examine the main effects and interactions of PS pasteurization (54.4o C for 2 h) and grain type (GT; dry rolled barley or corn) on ruminal and total tract digestion. Diets contained 7% alfalfa hay and 14% PS (DM basis) and were fed ad libitum three times daily. Corn-containing diets had 71.7% corn while barley diets had 60% barley and 11.7% corn. Acid detergent insoluble ash was used as an internal digestibility marker. Steers fed barley diets had greater ($P < 0.05$) intake but lower ($P < 0.05$) total tract digestibility of DM, OM, and ADF than steers fed corn diets. Treatment differences were not observed for starch digestibility. Ruminal fluid pH was lower ($P < 0.05$) for pasteurized compared with non-pasteurized PS treatments, and was lower ($P < 0.05$) for corn compared with barley treatments at 0200 and 2100 sample times. Ruminal fluid pH was lower at 0200, 1400, 2100, and 2300 sample times for the corn plus pasteurized PS treatment compared with other treatments (sampling time x PS x GT interaction, $P < 0.05$). Minimum ruminal pH was lower ($P = 0.07$) for pasteurized than non-pasteurized PS diets. Maximum ruminal pH was greater ($P < 0.05$) for barley than corn diets. Steers consuming corn diets had less ($P = 0.06$) time with ruminal pH less than 6.0 than barley diets. Ruminal fluid ammonia concentration was greater ($P < 0.05$) for non-pasteurized than pasteurized PS treatments and for corn than barley treatments. Pasteurizing PS increased ruminal fermentation but was generally not interactive with GT. Also, the effect of pasteurization of PS on ruminal fermentation did not impact total tract digestion.

Key Words: Feedlot, Byproduct, Fermentation

328 Replacing corn or barley with potato processing by-product in beef finishing diets improves feed conversion efficiency and alters carcass fat distribution. J. Duynisveld*¹, E. Charmley¹, I. Mandell², and J. Aalhus³, ¹Agriculture and Agri-Food Canada, Nappan, NS, Canada, ²University of Guelph, Guelph, ON, Canada, ³Agriculture and Agri-Food Canada, Lacombe, AB, Canada.

The effects of replacing corn or barley in beef finishing diets with potato processing by-product (PPB) on beef cattle performance, feed conversion efficiency, carcass traits and meat quality were examined using 100 cross-bred British x exotic steers. The PPB comprised steamed potato peel and cull potatoes, cull French fries and potato starch. Ten pens of 10 steers each were assigned to one of five concentrate-grass silage diets comprised on a dry matter (DM) basis of 80% concentrate and 20 % silage. The five concentrates comprised either, all barley, all corn, equal parts barley and PPB (DM basis), equal parts corn and PPB (DM basis) or all PPB. Cattle were supplemented with 500 IU d⁻¹ alpha-tocopherol. Results were analyzed using mixed models procedure, examining linear and quadratic responses when PPB was substituted in barley- or corn-based concentrates. Linear declines ($P < 0.05$) in dry matter intake (kg and % body weight basis) were present when PPB was substituted into either corn or barley-based concentrates. The replacement of corn with PPB did not affect ($P > 0.05$) average daily gain (ADG; 1.4 kg d⁻¹), but there was a negative quadratic effect ($P < 0.05$) on ADG when PPB replaced barley. The replacement of corn or barley with PPB improved ($P < 0.05$) feed conversion efficiency, with a linear effect ($P < 0.05$) on feed efficiency as corn was replaced with PPB. In both barley- and corn-based diets, PPB substitution improved feed conversion efficiency ($P < 0.05$). Marbling scores tended to decline linearly ($P < 0.10$) with increased PPB in both corn and barley groups. Back fat thickness increased ($P < 0.10$) in corn-fed cattle with PPB substitution. In barley-based diets back fat thickness was unaffected but there were quadratic effects of PPB on dissected lean muscle and intermuscular fat, suggesting that inclusion of 50% PPB resulted in fatter carcasses

Key Words: Beef, Potato, Carcass

329 Corn milling byproducts and alfalfa levels in cattle finishing diets. P. L. Loza*, K. J. Vander Pol, G. E. Erickson, R. A. Stock, and T. J. Klopfenstein, University of Nebraska, Lincoln.

ABSTRACT: An experiment was performed with the objective of evaluating the performance of beef steers on diets consisting of increasing levels of corn milling by-products (BP) (50% wet corn gluten feed, 50% wet distillers grains; DM basis) and different alfalfa hay levels. 280 yearling steers (370 kg BW) were blocked (3 blocks) by weight, stratified within block and assigned to 35 pens (8 steers/pen). Pens were assigned randomly to one of seven treatments (5 pens total/treatment) in a 3 x 2 plus 1 experimental design. Treatments consisted of a control diet (0%BP, 7.5% alfalfa) and three BP levels at 25%, 50% and 75% diet DM, in combination with two levels of alfalfa. Alfalfa level was kept constant at 7.5% of DM or formulated for equal eNDF of control, i.e., 7.5, 5.0, 2.5, and 0% alfalfa for the 0, 25, 50, and 75% BP, respectively. Steers were fed for an average of 113 d and harvested at a commercial abattoir. Interactions were only observed between BP and Alfalfa level ($P < 0.05$) for marbling and YG. Quadratic responses ($P < 0.05$) to the BP level (0, 25, 50, and 75%BP, respectively) were observed for DMI (11.1, 12.0, 11.7, and 10.6 kg DM/d), ADG (1.81, 2.10, 2.07, and 1.77 kg/d), and G:F (0.162, 0.177, 0.176, and 0.167). Improved feedlot performance was observed at the 25 and 50% BP levels, without significant ($P < 0.05$) differences between 25 and 50% BP inclusion. These results suggest that the BP utilization in feedlot diets up to 50% will enhance production performance.

Key Words: Cattle Feeding, Distillers Grains, Maize Byproducts

330 Effect of corn bran and steep inclusion in finishing diets on performance and nitrogen balance of open dirt feedlots. K. M. Sayer*, G. E. Erickson, T. J. Klopfenstein, C. N. Macken, and K. J. Vander Pol, University of Nebraska, Lincoln.

Two experiments using calves fed 167 d from November to April (WINTER) and yearlings fed 126 d from May to September (SUMMER) were fed to evaluate the effects of decreasing digestibility of a finishing diet by replacing dry rolled corn (DRC) with corn bran and steep, on performance and nitrogen (N) balance in open feedlots. Cattle were stratified by weight and assigned randomly to one of four treatments. Dietary treatments for both trials included Control (CON), 30% Corn Bran (30/0), 30% Corn Bran/15% Steep (30/15), and 45% Corn Bran/15% Steep (45/15) with byproducts replacing DRC in the diet (DM basis). WINTER calves were implanted with Synovex-S and re-implanted with Revalor-S, and SUMMER yearlings were implanted with Revalor-S on d 21. Pens were cleaned four times in WINTER and three times during SUMMER, across all treatments. WINTER cattle on CON tended to eat less than cattle on byproduct diets (10.5 kg/d vs. 11.1 kg/d, $P = 0.06$), however no differences in final weight (600 kg) or feed efficiency (0.157) were detected ($P > 0.05$). SUMMER cattle were also not different in final weight (604 kg, $P > 0.05$) however, CON yearlings had lower DMI than those on the byproduct diets (10.9 kg/d vs. 11.6 kg/d, $P < 0.01$) and cattle on 30/0 were less efficient than other treatments (0.135 vs. 0.144, $P = 0.05$). WINTER percent N losses from the pen floor surface were 63.9%, 50.7%, 51.9%, and 35.8% for CON, 30/0, 30/15, and 45/15, respectively, ($P = 0.01$). SUMMER percent N loss of total N excreted was not different ($P > 0.05$) across treatments (averaging 60.1%) however, more N was removed in the manure from byproduct pens than CON pens (13.3 kg N/hd vs. 10.1 kg N/hd, $P = 0.01$). Adding steep with bran negates any negative impacts on animal performance while still reducing N losses from feedlot pens and increasing manure N removal. Byproduct diets may prove valuable in increasing N removed in manure and lowering percent N lost from the pen floor surface.

Key Words: Maize Byproducts, Nitrogen, Nutrient Management

331 Timing of flax supplementation for finishing cattle. E. J. Good*, J. S. Drouillard, T. J. Kessen, E. R. Loe, M. J. Sulpizio, M. A. Greenquist, S. P. Montgomery, J. J. Sindt, B. E. Depenbusch, and K. A. Hachmeister, Kansas State University, Manhattan.

An experiment was conducted with finishing beef heifers (n=80; 365 kg initial BW) to determine the optimal time and duration for supplementation of ground flaxseed (0 or 5% of DM). Treatment periods included:

0% flax fed for 109 d (AllControl), 5% flax fed for 109 d (AllFlax), 5% flax fed for 60 d followed by 0% flax fed for 49 d (FlaxEarly), and 0% flax fed for 60 d followed by 5% flax fed for 49 d (FlaxLate). At the end of the finishing period, hot carcass weight, USDA yield and quality grades, marbling score, subcutaneous fat thickness, longissimus muscle area, and percentage of kidney, pelvic and heart fat (KPH), were determined for each animal. Retail display life, 2-thiobarbituric acid reactive substances (TBARS), fatty acid composition, tissue vitamin E concentration, and sensory attributes of longissimus steaks also were evaluated. FlaxEarly increased ADG ($P < 0.05$) compared with AllFlax or FlaxLate, but neither DMI nor gain:feed were affected. Feeding FlaxEarly increased fat over the 12th rib ($P < 0.05$), but there were no differences in KPH, USDA quality grade, or TBARS among any of the treatments. A trained sensory panel evaluated myofibrillar tenderness, juiciness, flavor intensity, connective tissue amount, overall tenderness and off-flavor intensity of steaks, but detected no differences among treatments. Moreover, there were no differences among treatments with respect to Warner-Bratzler shear force, retail display life, or tissue vitamin E concentrations of longissimus steaks. Feeding flax increased ($P < 0.05$) levels of α -linolenic acid in the longissimus dorsi both pre- and post cooking, as well as in plasma. The α -linolenic acid content of plasma from cattle fed FlaxEarly returned to levels similar to those of AllControl cattle in response to removal of flax from the diet after 60 d. Feeding ground flaxseed resulted in no negative effects on meat quality, and may be most beneficial during the early finishing phase.

Key Words: Flaxseed, Meat Quality, α -Linolenic Acid

332 Effects of forage level and corn processing method in beef finishing diets containing wet corn gluten feed on finishing steer performance. P. L. Loza*, K. J. Vander Pol, G. E. Erickson, R. A. Stock, and T. J. Klopfenstein, *University of Nebraska, Lincoln*.

ABSTRACT: Sixty steer calves (398 kg BW) were individually fed for 101 d to evaluate two corn processing methods with two different levels of alfalfa (ALF) in finishing diets containing 25% wet corn gluten feed (DM basis). Steers were stratified by initial BW and assigned randomly to one of the four treatments in a 2 x 2 factorial design. Factors included corn processing as dry rolled (DRC) or reconstituted high-moisture corn (HMC), and ALF level of 0 or 7% of diet DM. No corn processing by ALF level interactions were observed ($P > 0.05$), thus only main effects are discussed. Steers fed HMC had lower ($P < 0.01$) DMI, lower ($P < 0.01$) ADG, but similar gain efficiency (ADG:DMI) as steers fed DRC. Alfalfa level did not affect ADG. A trend ($P = 0.14$) for an interaction between corn processing and alfalfa level was observed for ADG:DMI. The addition of ALF tended to decrease efficiency in the DRC diet, but ALF appeared to be beneficial in HMC diets, although not significant. In finishing diets containing wet corn gluten feed, the value of inclusion of forage such as alfalfa, may depend on corn processing method.

	DRC		HMC		SEM	<u/> P Values		
	0%	7%	0%	7%		Corn*	Corn	ALF
ALF	ALF	ALF	ALF	ALF		ALF	Corn	ALF
DMI	10.4	11.1	9.0	9.6	0.2	0.75	<0.01	0.01
ADG	1.71	1.68	1.36	1.47	0.05	0.31	<0.01	0.57
ADG:DMI	0.164	0.152	0.150	0.155	0.004	0.14	0.60	0.35

Key Words: Alfalfa, Maize Byproducts, Maize Processing

333 Using a dynamic ruminant model to understand the differences in performance of cattle fed rations based on barley and/or a potato processing-by-product. B. N. Nagorccka*, E. Charmley², and J. Duynisveld², ¹CSIRO Livestock Industries, Canberra, Australia, ²Crops and Livestock Research Centre Agriculture and Agri-Food Canada.

To assess the efficacy of barley Vs potato processing by-product, cattle were fed a background ration containing 31% barley and 60% silage for 85 days, and were finished for 79 days on a ration containing 18% forage and one of five combinations of rolled barley and potato (table). The observed feed conversion ratio (FCR) show a small but significant difference in favour of potato, however, the observed average intake and body weight (BW) gain decreased with increasing dietary content of potato. To understand these differences a mechanistic, dynamic ruminant model (AusBeef, supported by CSIRO) with a voluntary intake sub-model, was

used to simulate the experiment. The different time trends in the periodic observations of body weight (BW) gain and intake in treatments 1 to 5 could only be explained by including an adaptation time when potato was introduced into the ration. An adaptation time proportional to the amount of potato in the finishing ration resulted in predictions that accounted for 95% and 75% of the observed variance in DM intake and FCR, respectively (table). The adaptation time in treatment 5 could be removed by replacing barley with potato in the background ration, in which case simulations (for 80% potato) predict an average BW gain of 1.86 kg/d, an average intake of 10.10 kg/d, and an FCR of 5.43. It is concluded that cattle should perform 10% better on potato by-product compared to barley (treatment 1).

Treatment	1	2	3	4	5	
Potato/barley (%DM)	0/80	20/60	40/40	60/20	80/0	SE
DM intake (kg/d)						
observed	10.56 ^a	10.77 ^{ab}	9.98 ^b	9.13 ^c	8.16 ^d	.31
predicted	10.82	10.68	9.80	9.47	8.70	
BW gain (kg/d)						
observed	1.67 ^b	1.69 ^b	1.86 ^a	1.52 ^c	1.57 ^{bc}	.058
predicted	1.80	1.85	1.80	1.72	1.66	
Feed/gain (FCR)						
observed	6.30 ^a	6.39 ^a	5.37 ^b	6.03 ^a	5.20 ^b	.18
predicted	6.02	5.76	5.44	5.51	5.25	

a,b,c,d Values in same row with different letter differ ($P < 0.05$)

Key Words: Cattle, Potato, Adaptation

334 Digestion of pasture in response to fumarate in continuous culture. E. S. Kolver¹, P. W. Aspin¹, G. N. Jarvis², K. M. Elborough², and J. R. Roche*¹, ¹Dexcel Ltd., Hamilton, New Zealand, ²ViaLactia Biosciences (NZ) Ltd., Auckland, New Zealand.

This experiment tested the hypothesis that addition of an organic acid (fumarate) would increase energy capture from a pasture diet during ruminal fermentation. Pasture was fermented with 0, 10, 20, or 30 mM of fumarate constantly infused into four dual-flow continuous culture fermenters. Samples of digesta and gas emissions were collected during the last 3 d of four, 9-day experimental periods, according to a 4 x 4 Latin square design. Digestion characteristics responded linearly ($P < 0.05$) as fumarate increased from 0 to 30 mM. Concentrations of propionate and total volatile fatty acids increased by 74% and 19%, respectively as fumarate increased from 0 to 30 mM. Increasing fumarate reduced the ratio of acetate:propionate (2.4 v.s. 1.5) and reduced ($P = 0.057$) methane production by 38%. These results were consistent with fumarate acting as an electron-accepting intermediary in the succinate-propionate pathway. Although 30 mM fumarate increased ruminal pH by 0.16 units compared to 0 mM fumarate (pH 6.23), the digestibility of neutral detergent fibre and acid detergent fibre was not changed. Concentration of lactate was low (0.12 ± 0.03 mM) and was not affected by fumarate supplementation. Fumarate did not influence nitrogen digestion, but true dry matter and organic matter digestibilities were reduced by 3.9 and 3.2 percentage units, respectively at 30 mM fumarate. The increased concentration of propionate appears to be a direct response to additional substrate (fumarate), rather than by an indirect improvement in lactate utilisation or fibre digestibility. The addition of fumarate increased energy capture from a pasture diet by improving the supply of glucogenic compounds and reducing losses to methane emissions.

Key Words: Fumarate, Pasture, Methane

335 Effect of gossypol from cottonseed meal consumption on performance of fallow does (*Dama dama*). S. Mapel*, D. Neuendorff, A. Lewis, and R. Randel, Texas A&M University, Texas Agricultural Experiment Station, Overton, TX.

The objectives of this study were to determine the effects of gossypol ingestion on reproductive function and productivity of female fallow deer (*Dama dama*) by measuring endocrine function, pregnancy rates, and BW of does and fawns. A group of multiparous fallow does were randomly allocated by BW into three treatments and placed on separate 0.809 ha Coastal bermuda grass pastures. Two bucks, fitted with marking harnesses, were housed with each doe group for the duration of the experiment. The treatments varied the amount of free gossypol (FG) in the diet. Animals were fed daily from 6/16/03 until 11/20/03.

The soybean meal group (SBMG; n = 17) was supplemented daily with 362 g of soybean meal (SBM)/animal. The low cottonseed meal group (CSML; n = 17) was supplemented with a mixture including 181 g of SBM and 227 g cottonseed meal (CSM; 0.09 % FG). The high cottonseed meal group (CSMH; n = 16) was supplemented with 454 g CSM/animal. The daily intake of FG/animal for SBMG, CSML, and CSMH was 0.0, 0.20, and 0.41 g, respectively. Beginning 8/14/03, BW, BCS, and serum blood samples were collected weekly, until 11/20/03. Ultrasonography, for pregnancy detection, was performed for all does on 11/20/03 and 12/15/03. The SBMG (-49.83±4.08 g/animal/d) lost less (P<.01) BW than CSML (-73.84±4.08 g/animal/d) or CSMH (-77.01±4.08 g/animal/d). Average daily BW loss did not differ (P>.1) between CSML and CSMH. Body condition score (5.36±0.09), pregnancy rates (100%), and time between weaning and conception did not differ (P>.1) among treatments. Doe serum progesterone concentrations were reduced (P<.05) in CSMH relative to SBMG and CSML. Among lactating does, BW and BCS at weaning was correlated (P<.01, R=-0.50 and P<.05, R= -0.41, respectively) with time between weaning and conception. Despite reductions in BW gains and serum progesterone concentrations, consumption of CSM (8.1 mg FG/kg BW; 0.41 g FG/animal/d) did not affect reproductive performance of fallow deer.

336 Soybean hulls for finishing meat goats. M. H. Poore*, J. A. Moore, A. T. Maye, and J.-M. Luginbuhl, *North Carolina State University.*

Soyhulls (SH) have been used at high levels in goat diets, but feeding method has not been studied. Twenty-four wethers, at least 75% Boer (21 kg), were allotted to 4 treatments (trt). All trt used orchardgrass hay (10.5 % CP and 65.9% NDF). Treatment 1 (hay) was 100% hay, trt 2 (HFcorn) was 33% hay and 67% hand-fed corn/SBM mix (12.5% CP and 11.0% NDF), trt 3 (HFSH) was 33% hay and 67% hand-fed SH (12.3% CP and 64.2% NDF), and trt 4 (FCSH) was hay at 0.75% of

live wt with free choice SH. One goat on HFcorn was removed due to low intake. All goats were started slowly on concentrate (conc) with ad lib hay. Initially, loose SH were fed, but after the first wk most goats were refusing their SH, so they were changed on d 12 to a pelleted source which was acceptable to all goats. Once all goats began consuming their conc at 33% of diet DM, they were fed 50% conc for 3 d and then 67% conc for 3 d. Following that, trt 4 received SH free choice and hay intake was restricted. All goats were on final diets by d 28. Ruminal samples were taken by rumenocentesis 4 h after feeding on d 84, and goats were harvested on d 85. Contrasts determined were hay vs. the other 3 trt (C1), HFcorn vs. HFSH (C2), and HFSH vs. FCSH (C3). Due to differences in dressing %, final live wt was adjusted using carcass wt and the average dressing % for all trt to calculate ADG. The study showed that all conc trt outperformed hay, that HFcorn was similar to HFSH, and that there was little difference between HFSH and FCSH. Therefore, SH are a viable feed for finishing goats, and can be fed free-choice.

Item	Hay	HFcorn	HFSH	FCSH	SEM	C1*	C2*	C3*
DMI, g/d	557	685	764	709	25.5	.01	.05	.13
Carcass wt, kg	9.3	14.6	14.5	14.3	.44	.01	.88	.76
Loineye, sq cm	11.0	14.6	15.1	17.1	.81	.01	.28	.24
KPH, %	1.55	3.60	2.66	2.72	.34	.01	.08	.90
Dressing %	40.5	51.0	50.4	53.2	.85	.01	.65	.03
Adj ADG, g/d	-19.6	100.7	103.7	92.8	9.17	.01	.82	.40
Gain:feed	-.036	.145	.135	.130	.011	.01	.57	.77
Ruminal pH	6.37	5.94	6.08	6.23	.090	.01	.28	.24
Ruminal A:P	3.52	1.85	3.83	4.49	.210	.99	.01	.01

*P value for contrast

Key Words: Meat Goats, Soybean Hulls, Carcass

Ruminant Nutrition: Dairy - Protein & Amino Acids

337 Effects of parity and levels of protein on production response and n-balance in holsteins. S. A. Flis* and M. A. Wattiaux, *University of Wisconsin-Madison.*

Eight Holstein cows (4 primiparous and 4 multiparous) were used in a replicated 4x4 Latin Square to determine milk production response and N balance when diets had no excess of RUP or RDP (C), 10% RUP excess (U), 10% excess RDP (D), or 10% excess of both RUP and RDP (UD) according to NRC 2001. Solvent soybean meal and soyPLUSTM made up 6.6 and 5.1, 6.1 and 7.5, 11.8 and 1.2, or 11.3 and 4.1% for the C, U, D, and UD diets, respectively. Diets were fed as a TMR with 25% alfalfa silage, 25% corn silage (DM basis) and corn grain as the primary source of dietary starch. During each 21day period, milk yield and DMI were recorded daily, and in the last 3 days of each period fecal and urinary N (UN) excretion were determined from total collection. Dietary CP averaged 17, 18, 17.6, and 18.7% for the C, U, D, and UD diet, respectively. DMI, milk and protein yield were lower in primiparous than in multiparous cows (P < 0.05). N intake (NI) was 535 and 782 g/d for primiparous and multiparous cows, respectively (P < 0.01). Total milk N (TMN g/d), fecal N and UN were lower for primiparous than for multiparous cows (P < 0.01), but N balance did not differ with parity (P = 0.2). Highest DMI and NI were in diets with excess RUP (see Table). Milk yield was lower on diets with excess RDP (D and UD) (P < 0.05). Fecal N, UN, and N balance (data not shown) were higher in diets with excess RUP. N balance was positive for all treatments. Through the trial little change in BW was observed. Results indicated that greater efficiency of N utilization on farm could be obtained by balancing rations for first and later lactation cows separately.

	Treatment		P-Value					
	C	U	D	UD	SEM	D*	U**	UxD
DMI kg/d	22.7	24.4	21.1	23.6	0.9	0.07	<.01	0.57
NI g/d	618	707	596	712	24	0.62	<.01	0.46
Milk kg/d	38.8	40.6	37.4	38.6	1.2	0.04	0.06	0.71
Fat kg/d	1.28	1.42	1.35	1.22	0.08	0.25	0.89	0.02
%Fat	3.32	3.52	3.65	3.24	0.17	0.80	0.37	0.02
Prot kg/d	1.00	1.07	1.00	0.99	0.05	0.18	0.30	0.20
%Prot	2.59	2.66	2.68	2.61	0.11	0.76	0.97	0.14
TMN g/d	175	189	169	181	8.31	0.21	0.06	0.92
Fecal N g/d	209	232	190	208	10	<.01	<.01	0.68
UN g/d	194	213	202	223	7.35	0.26	0.02	0.88

*P-value for D and UD vs. U and C
 **P-value for U and UD vs. D and C

Key Words: Nitrogen, N-Balance

338 Site of digestion in dairy cows fed different sources and amounts of crude protein. I. R. Ipharraguerre*¹, J. H. Clark¹, and D. E. Freeman², ¹Department of Animal Sciences, University of Illinois, Urbana, ²Department of Veterinary Clinical Medicine, University of Illinois, Urbana.

Six multiparous Holstein cows cannulated in the rumen and duodenum that averaged 70 DIM were used in a 6x6 Latin square design with a 2x3 factorial arrangement of treatments. Two sources of CP (soybean meal (SBM) and a mixture of SBM and a commercial blend of high rumen-undergradable (RUP) CP sources) and three contents of dietary CP (about 14, 16, and 18%) were combined into six dietary treatments. Each source of CP supplied about 50% of the CP mixture used to formulate the high RUP diets. On DM basis, diets contained 25% corn silage, 20% alfalfa silage, 10% cottonseed, 26.7 to 37% corn grain, and 4 to 13.5% CP supplement. Diets were fed twice daily for ad libitum intake. Intakes of DM, OM, and NDF, and OM truly digested in the rumen were unaffected by treatments (P >.05; mean = 23.2, 21.7, 6.8, and 8.9 kg/d, respectively). As dietary CP increased from 14 to 18%, starch intake (8.0, 7.1, and 6.7 kg/d) and apparent ruminal (3.4, 2.8,

and 1.6 kg/d) and total tract digestion (7.6, 6.7, and 6.4 kg/d) decreased ($P < .01$). At 14% CP, starch intake and total tract digestion (+.7 and +.6 kg/d) were higher for the RUP diet than the SBM diet, but the opposite occurred at 16% CP (.8 and .8 kg/d, $P < .01$). Across CP sources, increasing CP in the diet from 14 to 18%, increased N intake (510, 612, and 668 g/d, $P < .01$), ruminal outflow of nonammonia N (521, 536, and 617g/d, $P < .03$), nonammonia nonmicrobial N (224, 264, and 365 g/d, $P < .01$), Lys (157, 171, and 220 g/d, $P < .02$), total essential AA (1177, 1253, and 1531 g/d, $P < .02$), and total AA (2525, 2688, and 3265 g/d, $P < .02$). Across CP percentages, replacing SBM with RUP in the diet increased Met intake (57 vs. 63 g/d, $P < .01$) but did not affect Met flow to duodenum (61 vs. 64 g/d, $P > .05$). Ruminal outflow of microbial N (mean = 270 g/d) and milk yield (mean = 30.1 kg/d) were unaffected by treatments ($P > .05$). Data suggest that SBM-corn-based diets containing about 16% CP can quantitatively optimize the supply of N to duodenum of dairy cows consuming large amounts of feed.

Key Words: Nutrient flows, Protein, Dairy cows

339 Performance of lactating dairy cows fed different sources and amounts of crude protein. I. R. Ipharraguerre* and J. H. Clark, *Department of Animal Sciences, University of Illinois, Urbana.*

Sixty multiparous Holstein cows were involved in a 210-d lactation trial using a completely randomized design with a 2x3 factorial arrangement of treatments. Two sources of CP (soybean meal (SBM) and a mixture of SBM and a commercial blend of high rumen-undergradable (RUP) CP sources) and three concentrations of dietary CP (about 15, 17, and 19%) were combined into six dietary treatments. Each source of CP supplied about 50% of the CP mixture used to formulate the high RUP diet. On DM basis, diets contained 25% corn silage, 20% alfalfa silage, 10% cottonseed, 26.7 to 37% corn grain, and 4 to 13.5% CP supplement. Diets were fed twice daily for ad libitum intake. Across the 210 d and treatments, DM intake (DMI); yields of milk, 3.5% FCM, fat, and true protein (TP); FCM/DMI; and body condition score (BCS) averaged 24.6, 37.8, 36.8, 1.26, and 1.10 kg/d; 1.51; and 2.82, respectively. Most of these variables, however, showed a significant ($P < .05$) interaction between concentration and source of CP. At 19% CP, cows fed SBM had greater DMI, yields of FCM, fat, and TP (+2.5, +2.2, +.11, and +.05 kg/d), but lower FCM/DMI (.06) and BCS (.27) than cows fed RUP. At 17% CP, cows fed RUP had higher yields of FCM, fat, and TP (+2.9, +.13, +.05 kg/d) and FCM/DMI (+.06) than cows fed SBM. At 15% CP, cows fed SBM had higher DMI (+.6 kg/d) but lower yield of TP (.07 kg/d) and FCM/DMI (.06) than cows fed RUP. Across CP sources, cows fed 15% CP compared with cows fed 17 and 19% CP showed lower ($P < .05$) yields of FCM and TP (mean = 35.8 and 1.06, 36.7 and 1.13, 37.9 and 1.13 kg/d, respectively) and tended ($P < .07$) to have lower FCM/DMI (mean = 1.49, 1.49, and 1.55, respectively). Across CP percentage, cows fed RUP showed higher FCM/DMI than cows fed SBM (mean = 1.54 vs. 1.48). As dietary CP increased from 15 to 19%, milk urea nitrogen increased on average from 8.89 to 14.48 mg/dl. Data indicate that CP content of the diet of lactating dairy cows can be decreased without decreasing milk and milk component yields if the source and amount of dietary CP and carbohydrate are properly matched.

Key Words: Performance, Protein, Dairy cows

340 Effects of different protein supplements on nitrogen utilization in dairy cows. I. Lactation performance and ruminal metabolism. A. F. Brito*¹ and G. A. Broderick², ¹University of Wisconsin, Madison, ²US Dairy Forage Research Center, Madison, WI.

Sixteen multiparous and 8 primiparous Holstein cows (8 with ruminal cannulae) were randomly assigned to six 4 x 4 Latin squares to investigate the effects of RDP source on lactation performance and ruminal metabolism. All diets contained (% of DM): 20.7% alfalfa silage and 35.1% corn silage. The following protein supplements were added to the basal diet (% of DM): urea (1.9%; diet A), solvent soybean meal [(SSBM; 12.1%); diet B]; cottonseed meal [(CSM; 14.1%); diet C]; or canola meal [(CM; 16.1%); diet D]. Diets contained 16.6% CP. Yield of milk, fat, protein, and 3.5% FCM were significantly higher for cows fed diets supplemented with SSBM, CSM, or CM. Feeding CM resulted in numerically greater responses, although not always statistically different from SSBM and CSM. Cows fed diet A had the lowest DMI while cows

on diet D had the highest; diet C was intermediate but not different from diet B. Milk fat content, total VFA, acetate, and propionate were similar among all diets whereas milk protein content was highest on diets B and D and lowest on diets A and C. Ruminal pH and butyrate also did not differ across diets (data not shown). Overall, use of true proteins improved N utilization versus NPN. However, greater protein yield indicated that SSBM and CM were more effective than CSM.

Item	A		B		C		D	
	Urea	SSBM	CSM	CM	SED	P>F		
DMI, kg/d	22.1 ^c	24.2 ^b	24.7 ^{ab}	24.9 ^a	0.4	<0.01		
Milk yield, kg/d	33.3 ^b	40.0 ^a	40.6 ^a	41.2 ^a	1.1	<0.01		
FCM, kg/d	30.7 ^b	37.1 ^a	36.7 ^a	38.8 ^a	1.2	<0.01		
Milk fat, %	3.24	3.09	2.94	3.14	0.16	0.32		
Milk fat, kg/d	1.01 ^b	1.22 ^a	1.18 ^a	1.29 ^a	0.06	<0.01		
Milk protein, %	2.90 ^b	3.15 ^a	2.97 ^b	3.12 ^a	0.05	<0.01		
Milk protein, kg/d	0.91 ^c	1.23 ^a	1.18 ^b	1.27 ^a	0.04	<0.01		
Ruminal NH ₃ , mM	7.8 ^a	5.9 ^b	5.7 ^b	5.9 ^b	0.53	<0.01		
Ruminal total VFA, mM	88.7	92.1	90.3	89.9	2.85	0.68		
Ruminal acetate, mM	53.1	55.7	56.3	54.7	1.60	0.22		
Ruminal propionate, mM	19.9	21.6	19.0	20.6	1.26	0.22		

Key Words: Protein Supplements, Milk Yield, Dairy Cows

341 Effects of different protein supplements on nitrogen utilization in dairy cows. II. Digesta flow and bacterial protein synthesis. A. F. Brito*¹ and G. A. Broderick², ¹University of Wisconsin, Madison, ²US Dairy Forage Research Center, Madison, WI.

Eight multiparous Holstein cows fitted with ruminal cannulae were randomly assigned to two 4x4 Latin squares to investigate the effects of RDP source on digesta flow and bacterial protein synthesis. All diets contained (% of DM): 20.7% alfalfa silage and 35.1% corn silage. The following protein supplements were added to the basal diet (% of DM): urea (1.9%; diet A), solvent soybean meal [(SSBM; 12.1%); diet B]; cottonseed meal [(CSM; 14.1%); diet C]; or canola meal [(CM; 16.1%); diet D]. Diets contained 16.6% CP. Digesta flow (Co-EDTA and YbCl₂) and bacterial markers (¹⁵N) were continuously infused into the rumen. The omasal sampling technique was used to collect digesta from the omasal canal. Both DM and OM flows were lowest for cows fed diet A but similar among diets B, C, and D. Apparent ruminal dry matter digestibility (ARDMD) was highest on diet A, lowest on diet C, and intermediate on diets B and D. Organic matter apparently digested in the rumen (OMADR) and organic matter truly digested in the rumen (OMTDR) did not differ among diets. Fluid-associated bacteria (FAB), particle-associated bacteria (PAB), total bacterial flow, and bacterial efficiency were all higher in cows fed SSBM, CSM, or CM. Overall, bacterial non-ammonia nitrogen (NAN) flow and efficiency were increased by feeding true protein supplements rather than a NPN source (urea).

Item	A		B		C		D	
	urea	SSBM	CSM	CM	SED	P>F		
DMI, kg/d	21.4 ^b	23.6 ^a	24.1 ^a	24.7 ^a	1.0	0.03		
DM flow, kg/d	13.0 ^b	15.1 ^a	16.2 ^a	16.5 ^a	0.7	<0.01		
OM intake, kg/d	20.0 ^b	21.8 ^{ab}	22.2 ^a	22.8 ^a	1.0	0.05		
OM flow, kg/d	10.7 ^b	12.4 ^a	13.4 ^a	13.3 ^a	0.6	<0.01		
ARDMD, %	39.5 ^a	36.2 ^b	32.4 ^c	34.6 ^{bc}	1.2	<0.01		
OMADR, kg/d	9.3	9.4	8.8	9.4	0.5	0.55		
OMTDR, kg/d	14.2	15.7	15.8	16.0	0.7	0.12		
FAB NAN flow, g/d	173 ^b	194 ^{ab}	180 ^b	205 ^a	11	0.05		
PAB NAN flow, g/d	199 ^b	235 ^a	249 ^a	234 ^a	16	<0.01		
Total bacteria								
NAN flow, g/d	371 ^b	429 ^a	428 ^a	439 ^a	21	<0.01		
Bacterial efficiency, g/kg OMTDR	27.7 ^b	30.6 ^a	31.5 ^a	31.2 ^a	0.8	<0.01		

Key Words: Protein Supplements, Bacterial NAN Flow, Dairy Cows

342 Evaluation of prediction equations for estimating urinary output of nitrogen in lactating dairy cows. T. D. Nennich^{*1}, J. H. Harrison¹, D. Meyer², W. Weiss³, N. R. St-Pierre⁴, R. L. Kincaid⁵, M. Wattiaux⁶, and D. L. Davidson¹, ¹Washington State University, Puyallup, ²University of California, Davis, ³The Ohio State University, Wooster, ⁴The Ohio State University, Columbus, ⁵Washington State University, Pullman, ⁶University of Wisconsin, Madison.

Previously developed prediction equations need to be validated with other data sets to verify their accuracy across various diets and environments. The objective of this study was to evaluate previously published prediction equations that estimate urinary nitrogen excretion from lactating dairy cows. A data set was assembled from total urine collection studies that used multiparous Holstein cows (n = 418). The studies were conducted by Washington State University, University of California-Davis, The Ohio State University, and the University of Wisconsin. Milk production ranged from 1.4 to 86.1 kg/d. Dietary crude protein concentration averaged 17.5±5.8 and urinary nitrogen (UN) ranged from 63 to 499 g/d. Examples of previously published equations that were evaluated included UN (g/d) = N intake (g/d) x 0.83 milk N (g/d) 97 (J. Dairy Sci. 82:1261-1273) and UN (g/d) = 0.0259 x BW (kg) x MUN (mg/dl) (J. Dairy Sci. 84:2284-2294). Equations were evaluated by plotting residuals versus predicted values. The linear regression line of these plots was used to determine if mean or slope biases were present for any of the equations. The mean bias was not significant for any of the equations evaluated. However, there were significant slope biases for each of the equations. The new regression equation developed using this data set was UN (g/d) = 0.09 x DIM 0.94 x Milk (kg) + 0.20 x BW (kg) + 6.07 x DMI (kg) + 4.70 x MUN (mg/dl) + 11.42 x Dietary CP (%) - 281.53. Evaluation and validation of prediction equations is important to develop equations that will more accurately estimate urinary nitrogen excretion from lactating dairy cows.

Key Words: Rrine, Nitrogen, MUN

343 Meta analysis of the influence of different sources of methionine on the milk protein content of dairy cows. T. Guyot¹, J. C. Robert^{*2}, and D. Sauvat¹, ¹INA Paris, Grignon, Paris, France, ²Adisseo 42 Avenue Aristide Briand - 92160 Antony.

Several experiments have been carried out to study the influence of HMBi (2- hydroxy - 4 (methyl thio) butanoic acid isopropyl ester) on the milk protein content, at different doses and in comparison with HMB and SmartamineTM M (SmartamineTM M (Sm M) Adisseo) a coated form of methionine. The aim of this work was to compare the efficiency of HMBi on milk protein content vs other sources of methionine. A meta analysis was performed on a database including data from seven experiments. The rations were formulated to be adequate in term of metabolisable lysine supply. The data set was weighted by the number of cows in the experiment and the study effect was tested in the analysis. A first meta analysis was carried out in order to predict the increase of the milk protein content (MPC, g/kg) in relation to the quantity of methionine distributed to the cows (MQ ; g /animal/day). This took into account the methionine percentage of each product (70% for HMBi, 78% for SmartamineTM M and 88 % for HMB). The relationships were: for HMBi: MPC = 0.277 ln MQ (R² =0.83;SRD=0.12) ; for HMB: MPC = 0.001 ln MQ (R² =0;SRD=0.15) and for Sm M: MPC = 0.343 ln MQ (R² =0.85 ; SRD=0.14). Furthermore the following estimates of methionine bioavailability (50% for HMBi, 40% for HMB and 80% for Sm M) were used to calculate the quantities of metabolisable methionine supplied. A second meta analysis was performed in order to predict the increase of MPC depending on the quantity of metabolisable methionine (MMQ, g/animal/day). The relationships were: for HMBi and Sm M: MPC = 0.357 ln MMQ (R² =0.77; SRD= 0.11) ; for HMB: MPC = 0.002 ln MMQ (R²=0 ; SRD=0.15). Thus, the efficiency of utilization of both HMBi and SmartamineTM M at equivalent quantities of metabolisable methionine were not found to be significantly different. Moreover this meta analysis illustrates that only by conjugating HMB with isopropanol was sufficient HMB absorbed to increase the supply of metabolisable methionine necessary to increase MPC.

Key Words: Methionine, Ruminant, Nutrition

344 Use of changes in plasma sulfur amino acid concentrations to compare the ability of methionine (Met) products to provide absorbable Met to lactating dairy cows fed a Met-adequate diet. B. J. Olley¹, R. S. Ordway^{*1}, N. L. Whitehouse¹, and C. G. Schwab¹, ¹University of New Hampshire, ²Adisseo USA, Inc.

This experiment is part of an ongoing effort to develop an accurate and repeatable approach for determining differences among Met products in their ability to provide absorbable Met to lactating cows. Fifteen multiparous Holstein cows (212 ± 162 DIM) were blocked by milk yield, DIM, and milk protein content and assigned randomly to one of three 5 x 5 Latin squares. The basal diet was formulated to meet NRC (2001) requirements for energy and nutrients, including content of Met in metabolizable protein (MP). Adequacy of Met was achieved by adding SmartamineTM M to the basal diet to increase Met in MP from 1.76% to 2.14% to achieve an approximate 1:3 ratio with lysine in MP (6.51%). Each square consisted of top-dressing the basal diet with five amounts (treatments) of a single Met source. The three Met sources were SmartamineTM M, Met-PlusTM and Mepron M85[®]. Products were added to the basal diet to provide levels of Met supplementation of 0, 0.012, 0.024, 0.036 and 0.048% of DM. Treatments had no effect on concentration of total free AA in deproteinized plasma. Percent of Met and Met+cysteine (Cys) in total plasma AA for the five treatments were: SmartamineTM M (1.95, 2.06, 2.23, 2.48, 2.44; linear, P < 0.01 and 3.21, 3.42, 3.62, 3.84, 3.89; linear, P < 0.01), Met-PlusTM (1.88, 1.91, 1.99, 2.05, 1.98; P = 0.27 and 3.25, 3.40, 3.41, 3.41, 3.49; P = 0.168) and Mepron M85[®] (1.81, 2.16, 2.11, 2.03, 2.23; linear, P = 0.03 and 3.29, 3.65, 3.57, 3.48, 3.62; P = 0.168). Concentrations of Met and Met+Cys in total plasma AA were regressed on levels of Met supplementation. The slopes for Met-PlusTM and Mepron M85[®] were divided by the slope for SmartamineTM M to obtain a Met-bioavailability relative to that of SmartamineTM M. The described approach indicates that Met-PlusTM was 24% and 28% as effective as SmartamineTM M and Mepron M85[®] was 51% and 28% as effective as SmartamineTM M using changes in plasma Met and Met+Cys concentrations, respectively, in providing absorbable Met to lactating cows.

Key Words: Lactating Dairy Cows, Rumen Protected Methionine, Plasma Amino Acids

345 A simplified *in vitro* incubation medium with the potential to evaluate amino acid degradation in ruminants. F. L. Mould^{*}, R. Morgan, and K. Kliem, *Department of Agriculture, The University of Reading.*

Most *in vitro* assays use a modified Goering and Van Soest [1970] incubation medium [GVS]. However as some of the components are hazardous, difficult to obtain [developing countries] or of little impact [e.g. trace minerals] their omission should be examined. Hungate [1966] considered osmotic potential and buffering capacity to be more vital than composition, while Tilley and Terry [1963] argued that sufficient trace elements and growth stimulants were provided by the inoculum or substrate and that fermentation maintained anaerobic conditions. A modified [MOD] N-free medium based on GVS was prepared without the reducing solution or trace minerals and with NH₄HCO₃ replaced with NaHCO₃. The Reading Pressure Technique was used to compare these media with respect to the fermentation of maize starch and where MOD was supplemented with urea up to N levels equivalent to that supplied by GVS. The rumen fluid inoculum provided 10 mg N per flask. Cumulative gas values 4, 8, 12 and 24 h post-inoculation of 5.3, 27.6, 68.9 and 103.6 and 6.0, 32.8, 77.7 and 112.7 ml were recorded for GVS and MOD + nitrogen, respectively. The similarity between the two profiles indicates that a highly simplified, non-reduced medium is sufficient. With the urea dose titration, peak rate of gas release occurred 10 h post-inoculation and corresponded with the time point with the greatest differentiation between levels. Using the assumption that the urea-N was totally available, a highly significant regression between these 10 h gas values and supplemental N [r²=0.929, P>0.0001] was obtained. This indicates that gas release kinetics from the fermentation of a N-free substrate can be used as a complement assay to estimate supplemental N availability. Further, the comparison of gas profiles from known N sources with those of amino acids should permit the extent of their utilisation by rumen microorganisms to be determined, and subsequently the

degree to which commercial preparations confer amino acids protection against rumen degradation to be assessed.

Key Words: In Vitro, Simplified Medium, Amino Acids

346 Ruminant degradation of amino acids assessed using a complement *in vitro* technique. F. L. Mould*, K. Kliem, and R. Morgan, *Department of Agriculture, The University of Reading.*

Lysine and methionine are considered the first limiting amino acids in ruminant nutrition, however consistent treatment responses have generally only been found with maize-based diets offered to high-yielding dairy cattle. The potential loss of "protein value" or decreased efficiency of use following microbial degradation led to the concept of protecting free amino acids from rumen microbial degradation. However the extent of this degradation is unclear. A novel complement *in vitro* methodology was used to examine amino acid utilisation by rumen microorganisms. This technique uses the highly significant relationship between supplemental nitrogen availability and the rate of fermentation gas release.

Nine amino acids [Ala, Gln, Glu, Gly, His, Lys, Phe, Met and Ser] were compared to urea at 8, 12 and 16 mg N g⁻¹ maize starch. Each flask contained 1.0 g starch with the rumen fluid inoculum supplying 10 mg N. Each treatment was replicated five times with 16 h cumulative gas values obtained using the Reading Pressure Technique. Fermentation gas release [ml] for the three N inclusion levels [8, 12 and 16 mg] were 114, 118, 159, 97, 90, 85, 104, 92, 131 and 182; 120, 126, 174, 89, 91, 85, 102, 95, 136 and 216; and 111, 132, 197, 91, 86, 89, 91, 103, 135 and 246 for the amino acids, respectively. Compared with the control [0 mg N] value of 85 ml these results suggest that Gly, Hist, Lys and Phe were stable, Met marginal with only Gln and to a lesser extent Glu, Ala and Ser labile. AA-N utilisation, estimated by expressing gas release less the control values, relative to that of urea gave efficiencies of 0.243, 0.314, 0.712, 0.064, 0.035, 0.007, 0.125, 0.084, 0.391 for Ala, Gln, Glu, Gly, His, Lys, Phe, Met and Ser, respectively. If these results are confirmed *in vivo* where factors such as rumen absorption and outflow are considered, it is hypothesised that, provided adequate quantities are supplied [e.g. Met 120 % of requirement] "rumen protection" may not be needed to deliver sufficient levels of specific free amino acids post-ruminally.

Key Words: In Vitro, Amino Acid, Rumen Degradation

ABSTRACTS
Tuesday, July 27, 2004

POSTER PRESENTATIONS

* Author Presenting Paper

Contemporary and Emerging Issues

T1 Effect of inulin on the microflora of an ABT-type fermented milk during refrigerated storage. L. Varga*, B. Gyenis, N. Molnár, and J. Szigeti, *Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.*

The purpose of this research was to investigate the influence of inulin on the microbial flora of a probiotic fermented dairy product during refrigerated storage. Inulin-supplemented and control fermented acidophilus-bifidus-thermophilus (ABT) milks were produced using a fast fermentation starter culture as the source of *Lactobacillus acidophilus* (A), bifidobacteria (B), and *Streptococcus thermophilus* (T), and were then stored at 4°C for 42 d. Microbiological analyses and acidity measurements were performed at weekly intervals. Our results showed that the presence of inulin at 1.0% to 5.0% (w/v) did not significantly influence ($P > 0.05$) the survival of either *S. thermophilus* or *L. acidophilus* during storage. The viable counts of bifidobacteria fell more sharply than did those of lactobacilli and streptococci; however, the addition of inulin at 5% had a significantly beneficial effect ($P < 0.05$) on their viability after 28 d of refrigerated storage. No spoilage organisms were detected at any sampling time, indicating the high degree of sanitation during processing and packaging of the fermented milk products. In conclusion, the commercial inulin product tested was found to have prebiotic properties for bifidobacteria and, thus, it might be used for improving the viability of bifidobacteria in refrigerated fermented dairy foods. **Acknowledgments:** This work was funded by a grant (FKFP 0197/2001) from the Ministry of Education, Hungary. László Varga is grateful to the Hungarian Academy of Sciences for the award of a János Bolyai Research Scholarship.

Key Words: Inulin, Prebiotic, Bifidobacteria

T2 Evaluation of methods for detection of *Escherichia coli* O157:H7 in milk and occurrence of *Escherichia coli* O157:H7 in ex-farm raw milks in Hungary. A. Hucker¹, I. Mike-Schummel¹, L. Varga*², and A. Unger¹, ¹Hungarian Dairy Research Institute, Mosonmagyaróvár, Hungary, ²Department of Dairy Science, Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.

Escherichia coli O157:H7 poses a significant threat to public health. The main objective of this study was to evaluate the efficacy of classical protocols and an automated immunoassay system (mini-VIDAS) for detection of *E. coli* O157:H7 in raw milks containing background coliforms and *E. coli*, and in UHT milks deliberately spiked with non-pathogenic *E. coli* strains at various levels. In addition, the incidence of *E. coli* O157:H7 in Hungarian ex-farm raw milks was determined. As for the traditional protocols, PHLS Method 1 and FDA-BAM Method C were found to be highly suitable for detection of *E. coli* O157:H7 in non-pathogenic *E. coli*-spiked UHT milk and real raw milk samples, respectively. However, the mini-VIDAS *E. coli* O157 (ECO) system proved to be superior to the classical methods, with sensitivity, specificity, and accuracy percentages of 100, 97.9, and 99.3, respectively. Two hundred and fifty ex-farm raw milk samples were tested then in mini-VIDAS-ECO and in parallel by the FDA-BAM traditional protocol. The latter method gave 65 negative and 185 uncertain results, which required further identification, whereas mini-VIDAS-ECO gave one positive and 249 negative results. With both methods, only one out of the 250 samples tested was finally confirmed positive. The Duopath *E. coli* O157 test showed that this single positive sample contained an *E. coli* O157:H7 strain, which did not produce verocytotoxin. In conclusion, mini-VIDAS-ECO appears to be a potent tool for detection of *E. coli* O157:H7 in raw milk. With this system, 0.4% of Hungarian ex-farm raw milk samples were found to contain *E. coli* O157:H7.

Key Words: *Escherichia coli* O157:H7, Raw Milk, Immunoassay

T3 Use of powdered microalgae to stimulate acid production and growth of *Lactobacillus plantarum* and *Enterococcus faecium* in milk. B. Gyenis, L. Varga*, J. Szigeti, and N. Molnár, *Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.*

The objective of this research was to test the capability of microalgal biomasses to stimulate selected lactobacilli and enterococci in milk. Microalgae are photosynthetic microorganisms that can be used to produce high value compounds. Spray-dried microalgal biomasses typically contain 3% to 7% moisture, 46% to 63% protein, 8% to 17% carbohydrates, 4% to 22% lipids, 2% to 4% nucleic acid, 7% to 10% ash, 8% to 10% fiber, and a wide range of vitamins and other biologically active substances. *Chlorella vulgaris* is a green algal species that produces astaxanthin, canthaxanthin and, in minor amounts, β -carotene and lutein. *Arthrospira (Spirulina) platensis* is a planktonic cyanobacterium belonging to prokaryotic algae. It produces γ -linolenic acid in large amounts. The effect of powdered *A. platensis* and *C. vulgaris* biomasses, added at a concentration of 3 g/L, on growth and acid production of *Lactobacillus plantarum* and *Enterococcus faecium* strains primarily used for feed fermentation purposes was evaluated in milks with total solids contents ranging from 12% to 30%. The growth rate of and acid development by *L. plantarum* and *E. faecium* were found to be stimulated significantly ($P < 0.05$) by both *A. platensis* and *C. vulgaris* in all culture media formulations used. Microalgal biomasses had a more stimulatory effect on *E. faecium* than on *L. plantarum*. However, the dry matter content of milks did not influence the growth and acidification properties of the starter organisms tested. In conclusion, the *Chlorella* and *Arthrospira* biomasses rich in bioactive compounds are potentially suitable for use in cost-effective production of milk-based functional fermented feeds.

Key Words: Microalgae, *Lactobacillus plantarum*, *Enterococcus faecium*

T4 Do dairy producers market and manage dairy cows to improve beef quality? P. R. Tozer, G. A. Varga, D. Kniffen*, and W. R. Henning, *Pennsylvania State University, University Park.*

A survey of dairy producers in Pennsylvania was undertaken to ascertain the management of market cows and identify practices to improve the quality of beef from these animals. Ninety progressive dairy producers in Pennsylvania were selected based on recommendations from financial advisers and consultants. Of these 90 producers surveyed 69 provided usable responses to the survey. Producers were asked questions regarding how market cows were sold; condition of cows sold; drug residue notifications; vaccination and injection administration; foot trimming frequency and perceived mobility of market cows. Average herd size of respondents was 250 ± 218 cows, which is much larger than the Pennsylvania state herd average of 69 cows. The results of the survey indicated that most producers still market cattle through auction markets, however, the method of marketing varied across herd size, with smaller producers favoring auctions while larger producers preferred direct sales to the packer. The survey also showed that producers did not use marketing strategies to take advantage of seasonal cow beef price variability. The average number of injections given annually to dairy cows was 19.4 ± 12.4 . The percentage of injections given in the neck varied across strata, very few producers gave all injections in the neck, with a majority of injections (65%) given in other sites, with the tailhead or the hip/rump/flank area being identified as the most common site. Producers also reported an annual rate of 5% of the cows in the herd as downer cows. A downer cow is defined as one that cannot move without assistance. The principal cause of downer cows was metabolic disorders, although again there were differences observed across the different herd size strata. Smaller herds reported metabolic disorders as the principal cause of downer cows, whereas larger herds reported injuries as the major cause of downer cows. The results of this survey suggest that dairy producers have not identified the value in undertaking on-farm meat quality assurance programs.

Key Words: Beef Quality, Dairy, Marketing

T5 Effect of using aqueous extracts of Neem (*Azadirachta indica* A. Juss) seeds and leaves on oocyst count in calves. S. Pietrosemoli* and R. Olavez, *La Universidad del Zulia, Maracaibo, Venezuela.*

Aqueous extracts of seeds (AES) and leaves (AEL) of Neem tree were prepared in order to evaluate its potential effect on the oocyte counts (OPG) of grazing calves. Twenty-four crossbred *B. taurus* * *B. indicus* calves (45.6 ± 7.3 kg BW and 38.5 ± 2.49 d) naturally infected were allocated into 4 groups of 6 each; control (T0), 3 cc sulfonamide (25%) / kg BW (T1), AES (T2) 15 cc/ kg BW, and AEL (T3) 15 cc/ kg BW. Aqueous extract were prepared with 60 g of grounded Neem seeds (T2) and 300 g of freshly ground Neem leaves (T3), per liter of water, soaked during 12 hours before being filtered and orally administered once. Calves were fed milk (2 l/d), commercial concentrate (16% CP) *ad libitum*, and handled in *Brachiaria humidicola* pens. Pre and post treatment oocyst counts were performed by using the McMaster modified method on days -3, 7, 14, 21 and 28. Experimental design was a split plot, with treatment as main plots, and days of parasites count as split plots. Initial infestation ($4956,52 \pm 2127,74$) was used as covariate. Data were Log transformed as Log (n+1). Differences between treatments ($p \leq .03$) and days ($p \leq .004$) were found with T0 having the highest OPG count ($p \leq .05$). Although no statistic differences were observed between T1, T2 and T3, lowest OPG was recorded in T3 group. It was concluded that AES and AEL can reduce the oocyst count in calves.

Key Words: Coccidiosis, Calves, *Azadirachta indica*

T6 Neem's (*Azadirachta indica* A. Juss) leaves as feeding substrate for vermicomposting earthworm (*Eisenia andrei*). J. Hernández^{1,2}, S. Pietrosemoli^{1,2}, R. Palma², C. Tang*², C. Perozo², and R. Romero², ¹La Universidad del Zulia, Maracaibo, Venezuela, ²Proyecto S1-2000000792 FONACIT, Venezuela.

Four mixtures were tested in a small scale laboratory study, to evaluate Neems leaves potential to be used as feeding substrate for vermicomposting earthworm. Substrates tested were: 100% horse manure M, as substrate for comparison (S1); 100% Freshly-ground Neems leaves FN (S2); 50% M : 50% FN (S3) and 50% M : 50% 15 days shade dried Neems leaves (S4). Before being inoculated, all substrates were composted during 21 days. Four clitellated earthworm were maintained in cylindrical, covered, plastic containers (350 cc) during 84 days, with five replicates for treatment. Biomass and Total cocoon production were recorded weekly. Experimental design used was a split plot design, with substrates as main plot, and days of measurement as split plot. Initial weight (260.5 ± 3.1 mg / earthworm) was used as covariate. Cocoons production data were Log (Log (n+1)) transformed. All substrates supported growth and reproduction, and were successfully vermicomposted. Statistical differences were established between treatments for biomass ($p \leq 0.0001$) (407.0 ± 9.2 ; 844.9 ± 18.1 ; 490.1 ± 17.9 ; 497.0 ± 16.3 mg/ earthworm for S1, S2, S3 and S4 respectively), and for Total cocoon production ($p \leq 0.01$) (14.2 ± 1.2 ; 19.9 ± 1.4 ; 16.9 ± 0.6 and 13.6 ± 1.3 cocoons/earthworm, for S1, S2, S3 and S4 respectively). Earthworm biomass was higher in S2 substrate than in manure only substrate, which showed the lowest value, S3 and S4 achieved intermediate values. S2 showed also the highest values for cocoon production with statistical differences ($p \leq 0.05$) with the other substrates. The 100% Freshly-ground Neems leaves treatment (S2) was considered the best substrate for vermicomposting. It is concluded that Neems leaves can be vermicomposted successfully.

T7 Development and reproduction of *Eisenia andrei* using mixtures of cattle manure and Neems (*Azadirachta indica* A. Juss.) leaves. J Hernández^{1,2}, S Pietrosemoli*^{1,2}, C Contreras², R Palma², and A Faria^{1,2}, ¹La Universidad del Zulia, Maracaibo, Venezuela, ²Proyecto S1-2000000792, Venezuela.

Two laboratory scale experiment were performed in order to evaluate the suitability of use of freshly Neems leaves (NL), alone or mixed with cattle manure (M) to obtain vermicompost. In the first trial, biomass and reproduction were measured during eight weeks. The experimental design was a completely randomized, with 6 treatments and 7 replicates. Pairs of adult earthworms (767.78 ± 274.0 mg BW) were located in plastic containers (350 cc) with six different substrates: 100, 80, 60, 40, 20 and 0% of NL : M, which was used as control. Substrates were composted during 20 days before starting the trial. Weight gain and

cocoon numbers were recorded weekly. Statistical differences between substrates were not found. In the second trial, lasting 10 weeks, newborn earthworms (< 50 mg) from cocoons of the previous experiment were placed in plastic containers (950 cc; 10 per container) with the same substrates tested previously. Weight gain and established growth stage (Juvenile, Preclitellate, clitellate and regression of clitellum) were recorded weekly. The experimental design used was a completely randomized, with 6 treatments and 10 replicates. Statistical differences were observed between treatments; with highest biomass recorded in 80 % NL (535.3 ± 101.0 mg /earthworm), and the lowest in 100 % NL (302.6 ± 124.0 mg /earthworm). Reproductive activity started in week 5 and was observed until week 8. Substrates with 80 and 40 % NL showed highest total cocoon production (22.2 ± 16.88 and 31.0 ± 22.89 cocoons /earthworm respectively); meanwhile the lowest was registered with 100 % NL (4.2 ± 3.27 cocoons /earthworm). All substrates tested were completely vermicomposted. Success with these substrates, suggest that manures offer a well balanced nutrient content, able to satisfy growth and reproduction requirement.

T8 Acquisition and persistence of a high level macrolide resistant *Veillonella* sp. without selection pressure. T. Poole*, J. McReynolds, T. Callaway, and D. Nisbet, *USDA, ARS, College Station, TX.*

High level resistance to macrolide antibiotics, but not lincosamide or streptogramin antibiotics, is characteristic of enzymatic drug inactivation by macrolide phosphotransferase (*mph*) or esterase (*ere*) gene families. A *Veillonella* sp (VL2) was found to have acquired high level resistance to tylosin (a macrolide antibiotic), but not lincomycin, in a closed population of chicken cecal bacteria cultured anaerobically without antibiotic selection pressure. This suggests that a gene, or gene complex, conferring high-level macrolide resistance was acquired from a bacterial species present in the mixed anaerobic population. PCR amplification of VL2 genomic DNA with primers specific to known macrolide, lincosamide, and streptogramin resistance genes (*erm*, *ere*, *vat*, *mef*, and *msr* gene families) were negative. However, PCR amplification with *mph* A/B primers generated a DNA fragment of approximately 750 bp with tylosin resistant (TY^r) VL2, but not tylosin susceptible (TY^s) VL1 DNA. PCR amplification of genomic DNA from three *E. coli* isolates present in the same culture generated the expected (836bp) *mph* specific fragments. To date sequence alignments of the 750 bp fragment have shown partial amino acid identity with a *Salmonella* tyrosine kinase, but very little homology to published sequences of macrolide phosphotransferases. Additional studies are underway to determine the protein responsible for high level macrolide resistance by VL2, as well as the source of gene acquisition. To determine the competitive fitness of VL2, 10⁷ CFU/ml was inoculated simultaneously with 100ml of reconstituted PREEMPT (devoid of high-level tylosin resistant veillonella) to three continuous-flow fermentation devices. To date, two cultures have maintained VL2 for four months at 10³ CFU/ml without selective pressure. These preliminary experiments suggest a low metabolic cost from the acquisition of high level macrolide resistance.

Key Words: Antibiotic Resistance, Macrolide, Anaerobe

T9 Predation survival in rumen protozoa enhances *Salmonella* virulence. M. A. Rasmussen, S. L. Franklin*, and S. A. Carlson, *National Animal Disease Center, ARS,USDA, Ames, IA.*

The objective of this study was to determine if there is a relationship between predation by rumen protozoa and the enhancement of virulence in *Salmonella*. Previous research indicates that intracellular bacterial pathogens can become more pathogenic after engulfment, survival and release from free-living eukaryotic micro-organisms such as amoeba. In order to investigate if such relationships exist within the rumen microbiota, we determined the virulence of *Salmonella* strains after recovery from lysed preparations of mixed rumen protozoa. Virulence was determined using a tissue culture invasion assay (HEp-2 human carcinoma cells) and by monitoring disease progression after oral inoculation of *Salmonella* into calves. Laboratory cultured *Salmonella* isostrains not exposed to protozoa served as controls. Of the strains of *Salmonella* investigated (n=30), only those possessing the DT104 gene cluster encoding antibiotic resistance were found to be hyperinvasive (5-10 x greater than controls) after recovery from lysed rumen protozoa. The hyperinvasive strains included *S. typhimurium* DT104, U302 and multiple antibiotic resistant *S. infantis* and *S. agona*. When inoculated into calves, *S. typhimurium* DT104 recovered from rumen protozoa caused

a more rapid disease progression, including pyrexia (increased body temperature spikes), greater recovery of the bacteria from lymph nodes and spleen, and a more unfavorable prognosis resulting in earlier euthanasia. We conclude that intracellular bacterial/protozoal interactions in the rumen can enhance *Salmonella* virulence. The molecular mechanisms (and their relationship to antibiotic resistance) which contribute to intracellular survival and subsequent bacterial release from protozoa merit further investigation. These observations have implications for mechanisms of disease pathogenesis, rumen microbial ecology, fecal shedding of food borne pathogens from ruminants, and pathogen reservoir status of the rumen.

Key Words: *Salmonella*, Rumen Protozoa, Virulence

T10 More than grass: Organizing the emerging grass-fed beef market. L. Gwin*, *University of California, Berkeley.*

The U.S. market for grass-fed beef has gradually increased over the last decade, most recently spurred by public concern about food safety and the environmental impacts of conventional beef. Numerous challenges exist to the further expansion of grass-fed beef production, yet research on overcoming those challenges is scant. While many producers wish to remain small and sell via direct marketing methods (farmers markets, e.g.), others are attempting to bring grass-fed beef to larger, more mainstream markets. A major challenge is creating the economies of scale and consistency in supply and quality to meet the needs of large buyers such as retail stores, hotels, restaurants, and similar institutions. Managing pasture quality and forage availability though the year, and matching breeds to that forage, are other key challenges. In response, many grass-fed beef producers around the country have formed new programs. Interviews with program participants and review of documents from six such programs, each in a different region of the country, reveal similarities and differences in history, organizational structures, motivations and goals, and basic characteristics. Goals are often similar, yet models vary widely, from vertical integration to producer cooperatives. Programs are also typically rooted in their regions. While conventional commodity markets tend to create standardized products, often erasing regional variation, these programs take advantage of regional assets, both physical and socioeconomic. Yet balancing regional variation with market demand for consistency is addressed in different ways. One program sources nationally and favors the development of national standards for grass-fed, while another has partnered with county government to develop local certification. Consideration of regional assets is critical not only to program design and evolution but also to their future prospects. Understanding which strategies are being used to develop what is currently a niche market into a more mainstream sector will aid in the further development of grass-fed beef into a more widespread production scheme.

Key Words: Grass-Fed Beef, Business Organization

T11 Meat carcass inspection using fluorescence of dietary porphyrins. M. A. Rasmussen*¹, T. A. Casey¹, and J. W. Petrich², ¹*National Animal Disease Center, ARS,USDA, Ames, IA,* ²*Iowa State University, Ames.*

Feces on animal carcasses are an important source of food borne pathogens. Imaging devices that could assess the general level of carcass contamination would help to provide high quality meat products to consumers. Inspection procedures have relied upon unaided visual examination of carcasses but it is difficult to thoroughly inspect all carcasses in high speed processing plants using visual means. Imaging technology with real time capabilities and automated inspection would improve current procedures. In our research we have examined several fluorescent markers that could be used to optically detect fecal material. Excitation and emission spectra and fluorescent lifetime measurements were obtained for a variety of ingesta and fecal samples from cattle and other livestock species. Our analysis found that the most useful markers for fecal detection were the highly fluorescent metabolites of chlorophyll (pheophorbide and pyropheophorbide). These metabolites have peak excitation and emission wavelengths near 420 nm and 675 nm respectively. These metabolites are normally present in the G.I. tract of herbivorous animals consuming green plant material. These markers are particularly useful because the background fluorescence of meat is low in the far-red region of the visible spectrum. We have exploited the fluorescent properties of these chemical markers in the development of instruments,

which can detect fecal contamination on meat animal carcasses. Although diet can influence the fluorescent signal obtained, instruments have been designed with adequate sensitivity for the detection of feces from animals consuming a variety of commercial feedlot rations. This imaging technology has been developed through intellectual property protection and technology transfer into commercially produced instru-

ments, which are currently being manufactured and used by the meat processing industry. These instruments augment more time consuming microbiological testing methods and can assist slaughter plant operators and meat inspectors in their efforts to minimize contamination on meat.

Key Words: Feces, Fluorescence, Carcass Inspection

PSA - Nutrition 1

T12 Consequence of meeting non-phytin phosphorus (nPP) requirements with or without feed additives on broiler performance, litter P concentration and processing losses. A. S. Dhandu*¹, R. Angel¹, and W. W. Saylor², ¹Department of Animal and Avian Sciences, University of Maryland, College Park, ²Department of Animal and Food Sciences, University of Delaware, Newark.

Male Ross 308 broilers (56 birds/pen) were raised from hatch to 49 d of age in floor pens containing built up litter from two previous trials of identical design and dietary treatment (DT) allocation. Four feed phases were followed: starter, 1 to 18 d; grower, 18 to 32 d; finisher, 32 to 42 d; and withdrawal, 42 to 49 d. Six DT were tested (9 or 10 pens/DT). The nPP levels of DT 1 were in accordance with NRC (1994) recommendations: 0.45, 0.35, 0.35 and 0.30% nPP in the four feed phases. Following Univ. of Maryland recommendations, the nPP levels for DT 2 were 0.45, 0.31, 0.23 and 0.18%. In DT 3 and 4, nPP levels in the four phases were DT 2 levels reduced by 0.064 and 0.09%, respectively. For DT 5, the DT 1 nPP levels were lowered by 0.1%. The negative control was DT 6 and contained $\leq 90\%$ of DT 2 nPP levels. All diets in DT 3, 4 and 5 contained 600 U of phytase/kg diet. In addition, DT 4 contained 70mg of 25-hydroxycholecalciferol/kg diet. Pine shavings were weighed into pens before the first trial and litter was weighed out after the third trial. At 49 d of age, 22 birds per pen were selected at random, caught and transported by a commercial catching crew and then processed at a commercial plant following existing plant protocols. Tibiae and femurs of processed birds were analyzed for dry-defatted ash. The 49 d BW of birds fed DT 1, 2, 3 and 5 were greater ($P \leq 0.05$) than those fed DT 6. The total P excreted (per bird) by broilers fed DT 3 (12.73 g) and DT 4 (11.37 g) was lower ($P \leq 0.05$) than that of birds fed either DT 1 (19.53 g) or DT 5 (14.68 g). There was no effect ($P > 0.05$) of reducing dietary nPP on carcass yield, incidence of broken wings and legs or bruised back, breast, wings and legs. Tibia and femur ash of birds fed DT 1 was greater ($P \leq 0.05$) than that of those fed DT 6. Lowering dietary nPP concomitant with supplementation of feed additives achieved maximum reduction in litter total P without any negative impact on performance or on processing losses.

Key Words: Broilers, Phosphorus, Processing Loss

T13 The use of low-phytate soybean meal to reduce phosphorus excretion from poultts raised to 18 days of age. J. L. Godwin*, J. L. Grimes, A. G. Gernat, and M. J. Wineland, North Carolina State University, Raleigh.

An experiment was conducted to determine if feeding genetically modified low-phytate (LP) soybean meal (SBM) to turkey poultts would support growth performance equal to or better than those fed diets containing normal SBM and reduce phosphorus (P) excretion from poultts raised to 18d. A phytase enzyme (E) (Alltech; Kentucky) was also incorporated into the trial. One hundred and eighty eight Nicholas male turkey poultts were housed in Petersime batteries with 30 pens (6 birds per pen) at day of hatch with 5 pens per treatment. Five starter rations were fed to poultts in mash form. Treatments consisted of normal SBM+Ca and P at 100% of recommended NRC values (SBM100), LP+Ca and P at 100, 85, and 70% of recommended NRC (LP100, LP85, LP70, respectively) and LP70+enzyme (LP70E). Feed and water were provided ad libitum for 18d. The following parameters were measured; growth performance, AMEn, and apparent nitrogen retention (ANR). Feed consumption and feed to gain, by pen, and individual BW were determined at 6 day intervals to 18d. Also measured at 18d: percent toe and tibia ash, tibia breaking strength, and P levels in fecal samples. Neither mean BW, feed conversion, cumulative feed conversion, toe ash nor tibia ash were significantly affected by treatment. There was a significant linear decrease in tibia breaking strength and increase in AMEn as diets containing LP decreased from 100 to 70%. Tibia breaking strength for LP70E was not different from LP100. ANR and fecal P were significantly affected by

treatment. Fecal P decreased as NRC Ca and P level decreased in LP diets. Fecal P for SBM100 was higher than for LP100 while fecal P for LP70 and LP70E were not different. Using LP resulted in performance equal to SBM while providing reduced fecal P.

Key Words: Low-Phytate SBM, Phosphorus, Turkey Poultts

T14 Phytase activity and phytate hydrolysis along the digestive tract of broiler chicks: A comparative study of two phytase sources. E. M. Onyango*¹, M. R. Bedford², and O. Adeola¹, ¹Purdue University, West Lafayette, IN, ²Zymetrics Inc., Marlborough, Wiltshire, UK.

Residual activity of an *Escherichia coli*-derived phytase and a commercially available *Peniophora* phytase along the digestive tract of broiler chicks was compared in order to evaluate their relative resistance to hydrolysis in the digestive tract. Seventy two 7-d-old male broiler chicks were grouped by weight into six blocks of 3 cages with four birds per cage. Three corn-soybean meal-based diets were randomly assigned to cages within each block. The three diets were a low P diet containing 3.9 g P/kg diet; and low P diet plus either *Escherichia coli*-derived phytase or the *Peniophora* phytase at 1000 units/kg of feed. The chicks were fed experimental diets from 8 to 22 d of age. At the end of the study, chicks were killed and contents from the crop, proventriculus and gizzard, jejunum and ileum were collected, freeze-dried, ground and analyzed for phytase activity and phytate content. *Escherichia coli*-derived phytase had more residual activity at the crop ($P < 0.01$), proventriculus and gizzard ($P < 0.05$), jejunum ($P < 0.001$) and ileum ($P < 0.0001$) when compared with the *Peniophora* phytase. Less phytate remained in the digesta collected from the proventriculus and gizzard ($P < 0.05$), jejunum ($P < 0.01$) and ileum ($P < 0.05$) in birds fed *Escherichia coli*-derived phytase compared with those fed *Peniophora* phytase. The *Escherichia coli*-derived phytase may be more resistant to hydrolysis in the digestive tract when compared with the *Peniophora* phytase, and may be related to the superior phytate hydrolysis observed.

Key Words: Broiler Chick, *Escherichia coli* Phytase, Residual Phytase Activity

T15 Requirement of methionine of broilers during finishing period. F. Liu*, Z. Niu, and S. Zhai, College of Science & Technology, Northwest Sci-Tech University of Agriculture & Forestry.

The objective of this experiment was to evaluate the requirement of broilers during four to six weeks of age. Five hundred male broiler chicks from Arbor Acres commercial strains were divided into five groups, each of five replicates. The diets were based on corn-soybean meal which the level of methionine was 0.25%, 0.30%, 0.35%, 0.40%, 0.45% respectively. Each group of birds was fed one kind of the five diets above for two weeks. The results showed that there were significant effects of different levels of dietary methionine on growth performance and plasma uric acid content. BW and FC were significantly decreased at lower methionine (0.25% 0.30%), but uric acid level of plasma increased significantly. The BW and FC were not increased significantly at higher dietary level, but uric acid content was greatly increased. This study indicated that the requirement of methionine of broilers during finishing stage was 0.35% 0.40% in the diet.

Key Words: Methionine, Growth Performance, Broiler

T16 Impact of methionine source and excess choline on growth performance of broilers during the starter period. P. B. Pillai*¹, A. C. Fanatico¹, J. C. Townsend¹, K. W. Beers², and J. L. Emmert¹, ¹University of Arkansas, Fayetteville, ²Safe Foods Corporation, Rogers, AR.

Experiments were conducted to assess the impact of excess choline (CHO) or betaine (BET) on growth performance of broilers fed graded levels of DL-methionine (DLM) or 2-hydroxy-4-methylthiobutanoic acid (HMB) during the starter period. In experiment 1, a corn-peanut meal diet deficient in methionine (MET; 0.23% digestible) and cysteine (CYS; 0.25% digestible) was fed; treatments consisted of graded levels (0, 0.04, or 0.08%) of MET from DLM or HMB (additions adjusted for 88% purity) that were fed in the presence or absence of excess isomethyl CHO (0.25%) or BET (0.28%). In the experiment 2, identical treatments were used, but the basal diet was adequate in CYS (0.42% digestible). There was no overall impact of CHO or BET on growth performance in experiments 1 and 2 ($P > 0.05$); a significant improvement ($P < 0.05$) in weight gain and feed efficiency did occur with CHO and BET addition to basal diet in experiment 2. In both experiments, weight gain increased linearly ($P < 0.05$) with the addition of graded levels of DLM or HMB. Slope ratio methodology was used to assess HMB efficacy. In experiment 1, efficacy was 64.7% when HMB was fed without excess CHO or BET. Efficacy was significantly improved ($P < 0.05$) by excess CHO (79.2%) and numerically improved by excess BET (74.1%). In experiment 2, presence of adequate CYS improved HMB efficacy to 92.1%; addition of excess BET did not impact HMB efficacy (90.7%). However, addition of excess CHO to the CYS-adequate diet significantly reduced ($P < 0.05$) HMB efficacy (77.3%). In conclusion, excess CHO and BET appeared to improve HMB efficacy when added to a diet deficient in both MET and CYS, but not when added to a diet deficient in MET only. Further, presence of adequate CYS appeared to improve HMB efficacy relative to chicks fed a diet deficient in both MET and CYS. These data suggest that levels of CHO and BET and type of SAA deficiency impact HMB efficacy.

Key Words: Choline, Betaine, Sulfur Amino Acids

T17 The effect of dietary factors on induction of fatty liver-hemorrhagic syndrome and its diagnosis methods with use of serum and liver parameters in laying hens. M. Yousefi*¹, M. Shivazad², and I. Sohrabi Hafhdooost³, ¹Ph.D Student of Islamic Azad University, Science & Research Campus, Tehran, Iran, ²Department of Animal and Poultry Science, University of Tehran, Karaj, Iran, ³Department of Pathobiology, Islamic Azad University, Science & Research Campus, Tehran, Iran.

An experiment was conducted to determine: The effect of dietary factors on induction of fatty liver-hemorrhagic syndrome (FLHS) and its diagnosis methods with use of selected serum enzymes on Hy-Line W-36 hens. The experiment was conducted in completed random design (CRD) with 6 dietary treatments and 4 replicates pen each with ten hens from 94 to 106 wk of age. Three 28-d periods used from different dietary factors including: 1) control (C) 2) Low Methionine (LM) 3) Low Linoleic Acid (LLA) 4) High Energy (HE) 5) Low Methionine, Linoleic Acid, Choline and High Energy (LM-LLA-LCH-HE) and 6) Low Choline (LCH). Feed intake, body weight, egg production (EP), egg weight, egg quality, serum and liver parameters were measured the end of each 28-d periods. Overall feed intake was significantly ($P < 0.05$) lower for the hens fed HE diets compared to the control. Body weight was lower for all dietary treatments throughout the experiment compared to the control. Overall egg weight was significantly ($P < 0.05$) lower for the hens fed LM and LM-LLA-LCH-HE compared to the control. EP and egg quality were not significantly affected by dietary treatments. Overall liver hemorrhage score (LHS) was greater for the hens fed all dietary treatments except HE diet compared to the control. LHS was positively correlated ($P < 0.05$) with liver weight. Serum enzyme activities including: aspartate amino transferase (AST), alanine amino transferase (ALT), lactate dehydrogenase (LDH) were not significantly affected by dietary treatments. Although the AST enzyme activity was not significantly different, but it was numerically higher for all dietary treatments except HE diet. The results showed the effectiveness dietary factors on induction of FLHS in laying hens. AST enzyme activity could be used for diagnosis of FLHS in laying hens.

Key Words: Fatty Liver Hemorrhagic Syndrome, Dietary Factors, Enzyme

T18 The effect of dietary treatments flaxseed, yeast, soy fatty acid on fatty liver-hemorrhagic syndrome in laying hens. M. Yousefi*^{1,3}, M. Shivazad², and I. Sohrabi Hafhdooost³, ¹Department of Animal and Poultry Science, Islamic Azad University of Saveh, Saveh, Iran, ²Department of Animal and Poultry Science, University of Tehran, Karaj, Iran, ³Department of Pathobiology, Islamic Azad University, Science & Research Campus, Tehran, Iran.

An experiment was conducted to determine: 1) The effect of dietary treatments on fatty liver-hemorrhagic syndrome (FLHS) in Hy-line W-36 hens. The experiment was conducted in completed random design with 6 dietary treatments and 4 replicates pen each with ten hens from 106 to 110 wk of age. In experiment: different dietary treatments including: 1) Control (C)- 4% Soy Fatty acid + Methionine (4% SFA)- Linoleic Acid (LA)- 0.05% Yeast (*Saccharomyces Cerevisiae*) + Balanced Energy (0.05% SC)- Methionine + Linoleic Acid + Choline + Balanced Energy (M + LA + CH + BE) - 5% Flaxseed + Choline (5% FS) were compared for treatment of FLHS during 28-d period. In experiment: Body weight was lower for the hens fed all dietary treatments compared to the control. Egg weight was significantly ($P < 0.05$) lower for the hens fed 5% FS compared to the control. Liver weight was lower for the hens fed 0.05% SC and 5% FS compared to the control. Liver hemorrhage score was positively correlated ($p < 0.05$) with liver weight. The results showed body weight and liver weight are 2 of the inducing factors for FLHS that which were decreased by yeast and flaxseed.

Key Words: Fatty Liver-Hemorrhagic Syndrome, Dietary Treatments, Liver

T19 Efficiency of folate deposition in eggs throughout the production cycle of Hyline W98 and W36 laying hens. K. Hebert*¹, J. D. House, and W. Guenter, University of Manitoba, Winnipeg, MB, Canada.

With previous research to document that supplementing diets with 4 mg crystalline folic acid/kg yielded 90% maximal egg folate concentrations, a study was designed to determine the age and rate of production effects of laying hens on egg folate level, and the potential for differences due to strain of birds. Hyline W36 and W98 hens ($n = 156$ /treatment) received a barley-based ration, containing 0 and 4 mg/kg of crystalline folic acid for eleven 4-week periods. Response criteria included production parameters, egg quality measurements and measures of egg folate content. There was no significant difference ($P < 0.05$) in performance parameters or egg quality measurements due to folate supplementation. Hyline W98 had significantly ($P < 0.05$) higher feed consumption (FC), egg weight, yolk weight, body weight and lower percent yolk of egg weight than the W36 strain. Throughout the production cycle egg production (EP) and feed efficiency (FE) increased to peak and then decreased. FC, egg weight, yolk weight and percent yolk of egg weight significantly ($P < 0.05$) increased, and specific gravity significantly ($P < 0.05$) decreased throughout the production cycle. A significant ($P < 0.05$) ration x strain interaction was evident for EP and FC, as Hyline W98 hens exhibited higher EP and FC than W36 with supplementation level of 4 mg/kg. A significant ($P < 0.05$) strain x period interaction was evident for EP, FC, FE, egg weight and yolk weight. A significant ($P < 0.05$) ration x period interaction was evident for FC and FE. Overall, performance was not affected by long-term folate supplementation.

Funding: Manitoba Egg Producers, CEMA, Clark Hy-line Inc.

Key Words: Folate, Egg

T20 Effects of supplemental dietary Vitamin E and selenium from two sources of egg production and vitelline membrane strength in laying hens. D. Monsalve*, G. Froning, M. Beck, and S. E. Scheideler, University of Nebraska, Lincoln.

Separation of the egg yolk from the albumen is extremely important in order to avoid yolk contamination; the strength of the vitelline membrane (VMS) is a key factor in this step. Information concerning effects of vitamin E and selenium (Se) supplementation in hens on VMS, whipping performance, and production parameters during heat stress is limited. Two hundred eighty eight, 26 wk old Bovan laying hens were assigned to 48 cages (6 hens/cage) in a 3x2x2 factorial arrangement of 3 levels supplemental α -tocopherol E (50 or 100 or 150 IU/Kg), 2 levels of Se (0.25 ppm or 0.50 ppm), and 2 sources of Se (inorganic or organic) added to corn-soybean meal based diets. Birds were maintained

at environmental temperatures during the summer months of July, August, and September. Egg production, feed intake were recorded daily, egg weights were determined weekly, and body weight on a monthly basis. Eggs collected from each treatment were analyzed for vitamin E and Se content in the yolk, yolk pH, albumen pH, angel cake volume, foam stability, yolk viscosity, and Haugh units. An Instron universal testing machine (4500 series) equipped with back-extrusion food cell, with a 2-kg tension load and crosshead speed 10mm/min, was used to measure VMS of fresh and aged (2 weeks) eggs. Results showed that hens fed diets with 0.50 ppm of Se laid 1.68% more eggs, weighed 19 more grams, and consumed 2.58 g more feed than those fed the same diets with 0.25 ppm of Se. Addition of 150 UI/kg vitamin E in the diet significantly ($P \leq .05$) increased VMS of fresh eggs by 0.05 and 0.08 kg/mm, respectively, in contrast to 100 and 50 UI/kg vitamin E in the diet. A similar trend was observed with aged eggs, in which VMS was significantly ($P \leq .05$) greater for eggs from hens on diets supplemented with 150 UI/kg compared to 100 and/or 50 UI/kg vitamin E. This study suggests that addition of vitamin E and Se diets during summer time improved VMS for both fresh and aged eggs.

Key Words: Vitelline Membrane, Vitamin E, Selenium

T21 Performance of broilers fed diets containing 2-hydroxy-4-methylthiobutanic acid at different inclusion rates. A. B. Batal¹, J. L. Emmert², P. B. Pillai², B. L. Lumpkins*¹, and M. E. Blair³, ¹University of Georgia, Athens, ²University of Arkansas, Fayetteville, ³Adisseo, Alpharetta, GA.

Three experiments were conducted to evaluate the effects of feeding different methionine sources, 2-hydroxy-4-methylthiobutanic acid (RhodimetTM AT88, Adisseo) or DL-methionine (RhodimetTM NP 99, Adisseo) to broilers on performance and carcass yield. AT88 was added to the experimental diets on a weight basis according to assigned efficacy values (88, 82, and 70% in Experiment 1; 88, 82, 75, and 70% in Experiments 2 and 3). As the AT88 efficacy value decreased, the level of supplemented AT88 increased to meet the methionine requirement (e.g. DLM, 0.27%; AT88-88%, 0.307%; AT88-70%, 0.39%). Each of the dietary treatments was fed to 6 replicate pens of 45 (Experiment 1) or 25 chicks per pen (Experiments 2 and 3). Experiments 2 and 3 followed the same experimental design, protocol, and diets were mixed simultaneously at one location while the experiments were conducted at two different research facilities. A methionine-deficient basal diet was manufactured for each of the feeding periods; Experiment 1, 3 periods, starter (0-22 d), grower (22-42 d) and finisher (42-56d); Experiments 2 and 3, 4 periods starter (0-16 d), grower (16-32 d), finisher (32-40 d), and withdrawal (40-50 d). The basal diet was based upon the current Agri Stat commercial baseline values for nutrients, with supplemental methionine omitted (practical-type diet). In Experiment 1, growth rate and carcass yield of birds fed AT88 with an efficacy value of 88% was similar to birds fed DLM. However, birds fed AT88 with an efficacy value of 70% (such that more AT88 is added to the diet) had slightly reduced weight gain through out the study and numerically lower carcass yield relative to birds fed DLM or AT88 with an efficacy value of 88%. In Experiments 2 and 3, no effect on performance, carcass or breast meat yield were observed due to any AT88 efficacy level employed. The results suggest that even at a calculated efficacy of 88%, growth rate and carcass yield of broilers fed AT88 was similar to that of birds fed DLM and that lowering the efficacy of AT88 may depress carcass yield (Experiment 1).

Key Words: Methionine hydroxyl analog (AT88), DL-methionine, Broiler chicks

T22 The effects of dietary herbal extracts for broiler chickens. M. R. Lewis*¹, S. P. Rose¹, A. M. Mackenzie¹, and J. Smith², ¹National Institute of Poultry Husbandry, Harper Adams University College, UK, ²Braes Feed Ingredients Limited, UK.

Limitations concerning the use of antibiotics in poultry feed in Europe have stimulated the search for alternatives in order to remain competitive. Herbs contain many active components that have a wide range of pharmacological properties. However, as yet limited data have been presented to support their efficacy or elucidate mode of action in practical poultry diets. Initial screening experiments investigated the effects of 6 herbs (garlic, yarrow, horseradish, milk thistle, juniper and oregano) on growth performance. Birds fed yarrow supplemented diets (1800mg/kg) showed improved FCE ($P < 0.05$) in the latter growth stage (17-27 days

of age) compared with birds fed the unsupplemented control diets. Further experiments have focused on how yarrow exerts its performance effects. It was thought that antibacterial components found in yarrow (such as 1,8-cineole) might exert a positive effect on gut microflora. A large floor pen experiment was therefore conducted, and caecal populations of *Escherichia coli*, *Bacteroides fragilis* group and lactic acid bacteria were enumerated anaerobically. Consistent performance effects were seen in birds fed diets containing yarrow: higher weight gains, $P < 0.001$ and increased feed intake $P < 0.05$ relative to unsupplemented controls; 18-36 days of age. However, no differences were observed in caecal microflora populations, indicating that yarrow does not mediate its effects through moderation of gut flora. The latest in this series of experiments has concentrated on the effects of yarrow on nutrient digestibility in chicks fed adequate and diluted (10% less nutrient dense) diets with and without yarrow. There was a diet x yarrow interaction: birds fed diluted diets supplemented with yarrow showed higher feed intake ($P < 0.05$) and a tendency for higher weight gain ($P = 0.08$) than their non-supplemented counterparts. Initial evidence indicates that both diet dilution and yarrow supplementation increase pancreas weights. More detailed measurements of ileal pancreatic enzyme activity are currently underway. These data should provide a valuable insight into the *in vivo* mode of action of yarrow.

Key Words: Herbal, Yarrow, Digestibility

T23 Effects of organogermanium on performance and immune response in broilers. Z. Niu*, X. Liang, F. Liu, M. Xie, and Y. Wang, College of Animal Science & Technology, Northwest Sci-Tech University of Agriculture & Forestry, Yangling, China.

The objective of this experiment was to study the effects of carboxyethyl germanium sesquioxide (Ge-132) on the growth performance and immune response of broilers. 240 Avian broiler chicks were assigned to one of four dietary treatments which was supplemented with 0mg/kg, 30mg/kg, 80mg/kg, and 120mg/kg Ge-132 resp.. The birds were reared for 7 weeks. The result of the experiment indicated that: (1) There were no significant efficacy of supplemented with Ge-132 in diets on body weight, feed intake, growth rate, and feed efficiency of broilers at 49 days old of age; (2) The weight of immune organs, including bursa of Fabricius, thymus, and spleen, weren't affected significantly by supplementation of Ge-132, but the level of the antibody of NDV was significantly higher as compared with the control group at 28 days of age.

Key Words: Germanium, Immune Function, Growth Performance

T24 Justifying effects of grain particle size on broiler performance and carcass quality. A. S. Parsons* and J. S. Moritz, West Virginia University, Morgantown.

Corn particle size has been suggested to affect broiler performance. However, a specific understanding of particle size effects has not been determined. In a previous study, experimental treatments consisted of five similarly formulated mash diets varying in corn particle size (781 μ m, 950 μ m, 1042 μ m, 1109 μ m, 2242 μ m). Each of these diets was fed to 13 replicate floor-pens of 21 straight-run 308x344 Ross broilers during the growing period. Regression analysis showed an increasing trend in feed intake ($P = 0.0016$) and gizzard weight ($P = 0.0001$) as particle size of mash diets increased; however, feed efficiency ($P = 0.0058$) and percent breast yield ($P = 0.0250$) decreased. The objective of the current study was to explain these trends via true metabolizable energy (TME), particle size preference and passage rate studies using similar diets. Regression analysis of a six replicate TME study showed a quadratic trend ($P = 0.0049$) as dietary particle size increased. Particle size preference was determined by feeding diets to broilers (4.5 wk) over a 12 hr period with particle size determined at 3 hr intervals. Preference varied due to a treatment by time of collection interaction ($P = 0.0282$). Diet particle size either significantly or numerically increased during the initial 3 hr period, while remaining similar to initial diet particle size for the second 3 hr period ($P \geq 0.05$). Particle size of diets containing fine, small or coarse corn (864 μ m, 927 μ m, 1515 μ m respectively) decreased over the final 3 hr period ($P \leq 0.05$) suggesting that size preference decreased as availability of larger particles decreased. Particle size of diets containing medium or large corn (943 μ m and 1065 μ m respectively) decreased for the remaining 6 hr period ($P \leq 0.05$) suggesting again, there was a preference for larger particles. Despite an initial preference for smaller

particles, it was necessary for birds in the floor-pen study to also consume larger particles to allow replenishment of feed in the trough. Diets containing larger particles showed a decrease in TME, which may explain the increase in FI and the decrease in FE observed in the floor-pen study.

Key Words: Particle Size, TME, Preference

T25 Effects of pelleting protein concentrate pellets on feed mill throughput and electrical efficiency. P. M. Clark* and K. C. Behnke, *Kansas State University, Manhattan.*

The efficacy of blending cracked corn and a pelleted protein concentrate to improve feed mill throughput, with emphasis on electrical consumption and pellet quality, was studied. A complete, pelleted corn-soybean meal-based broiler grower diet (Diet 1) was compared to pelleted protein supplements blended with two levels of cracked corn (15% and 30%; Diet 2 and Diet 3, respectively). All diets were formulated to be isocaloric and isonitrogenous. No. 2 yellow dent corn was cracked on a Roskamp three-high roller mill. Roll gaps were set at 2.46 mm for the top rolls with the bottom two sets of rolls being left open to achieve a particle size of 75% of the corn + #10 U.S. screen. The roller mill and hammer mill were set for equivalent production rates and electrical consumption was collected on both machines. The sifted fines from the cracked corn were then returned to the diet as part of the corn fraction. The complete diet and protein pellets were formed on a CPM pellet mill using a 4 mm x 32 mm (5/32" x 1") die, conditioned at 82 °C (180 °F). Treatment comparisons were analyzed by ANOVA using the Proc Mixed procedure of SAS (2001). The roller mill consumed 4.4 kWh/ton less electricity than the hammer mill. This can be calculated to be approximately \$0.28/ton. The pelleted protein concentrates, Diet 2 and 3, were not significantly different ($P < .05$) than Diet 1 in pellet durability (PDI), % fines produced, and electrical energy consumption. PDI for Diets 1, 2, and 3 were 80.19, 80.74, and 82.49 respectively. Fines percentages for the diets were 7.1, 6.96, and 6.56% for Diets 1, 2, and 3. Electrical consumption of the pellet mill was 3.19, 3.19, 3.36 kWh for Diets 1, 2, and 3, respectively. Overall, throughput in a feed mill can be increased to approximately 20% without sacrificing pellet quality with minimal influence on electrical energy consumption.

Key Words: Pellet Quality, Electrical Consumption

T26 Effects of feeding blends of grains naturally-contaminated with *Fusarium* mycotoxins on performance and metabolism of turkeys. S. R. Chowdhury* and T. K. Smith, *University of Guelph, Guelph, ON, Canada.*

There is a lack of information in the literature regarding the effect of feeding turkeys grains naturally-contaminated with *Fusarium* mycotoxins. Studies were conducted, therefore, to characterize the toxicity to turkeys of grains naturally-contaminated with *Fusarium* mycotoxins and to determine the efficacy of a polymeric glucomannan mycotoxin adsorbent (GMA). Two hundred and twenty-five day-old male turkey poults were fed corn, wheat and soybean meal based starter (0-3 wks), grower (4-6 wks), developer (7-9 wks) and finisher (10-12 wks) diets for 12 wks. The diets included: (1) control (2) contaminated grains (3) contaminated grains + 0.2% GMA. The feeding of contaminated grains decreased weight gain compared to controls in the starter, developer and finisher period. Weight gains increased, however, when contaminated grains were fed in the grower period. Supplementation of contaminated grains with GMA, moreover, increased body weight gain compared to unsupplemented contaminated grains throughout the experiment. There were no significant effects of diet on feed consumption. Feed efficiency increased in the grower period but decreased in the developer period compared to controls when birds were fed contaminated grains. Plasma concentrations of calcium, total protein, albumin, globulin, and uric acid were decreased after 4 wks of feeding contaminated grains compared to controls. The feeding of contaminated grains increased plasma cholesterol concentration and decreased bilirubin and uric acid concentrations after 8 wks compared to controls. Plasma phosphorus concentrations increased after 4 wks, however, decreased after 8 and 12 wks of feeding contaminated grains compared to controls. It was concluded that turkeys are sensitive to the feeding of combinations of *Fusarium* mycotoxins as seen in the reductions in performance and the alterations in

plasma chemistry and that the feeding of GMA could largely prevent the mycotoxicosis from occurring.

Key Words: Turkey, *Fusarium* Mycotoxins, Performance and Metabolism

T27 Effect of Avizyme® 1502 on increasing protein and energy retention when feeding to Bovans White pullets. C. Troche*¹, X. Sun¹, C. Novak¹, and J. Remus², ¹*Virginia Tech, Blacksburg,* ²*Danisco Animal Nutrition.*

Bovans white leghorn pullets (n = 768) were used to determine the effect of Avizyme® 1502 (AZ 1502) on protein (PR) and energy retention (ER). Diets were formulated according to the management guide for the starter (S -0 to 6 wks), grower (G -6 to 10 wks), developer (D -10 to 15 wks) and pre-lay (P -15 to 18 wks) periods. The 18-wk 2 x 2 x 2 factorial experiment consisted of 2 levels of energy (ME 2980, 2970, 2960, 2842 kcal/kg for S, G, D, P vs 3% energy reduction per period), dietary protein (CP 20, 18, 16, 15 % for S, G, D, P vs 1% unit protein reduction per period) and AZ 1502 (w/wo). Enzyme was added at 0.05 % to 8 wks and at 0.0375 % from 9 to 18 wks. Each trt was replicated 8 times (12 birds per replicate pen). During the D period, feed consumption was reduced ($P < 0.05$) by the inclusion of enzyme (2205.4 vs 2141.6 g/b/period). No differences were seen in cumulative weight gain at 18 wks, while cumulative F:G was improved ($P < 0.05$) by the supplementation of AZ 1502 (4.64 vs 4.72). Pullets fed the high energy diets had superior ER ($P < 0.05$) in the S (82.8 vs 81.7%) and D periods (79.1 vs 76.3%), but reduced ($P < 0.05$) ER (82.0 vs 80.9%) during the G period compared to pullets fed the reduced energy diets. Pullets consuming high protein diets had improved ER ($P < 0.05$) in the S (83.0 vs 81.4%) and G periods (82.0 vs 80.9%) compared to the reduced protein group. AZ 1502 supplementation increased ER ($P < 0.003$) in the S (82.7 vs 81.8%) and G periods (81.8 vs 81.1%), but reduced ($P < 0.05$) it during the P period (77.7 vs 76.3%). PR also improved in the S and G periods with AZ 1502 addition but decreased in P. Feeding various levels of protein and energy w/wo enzyme had no affect on most growth performance criteria evaluated, but did influence nutrient retention. When evaluating production cost, AZ 1502 supplementation decreased overall cost by as much as \$0.01/kg of gain, making enzyme supplementation a worthwhile consideration for raising pullets.

Key Words: Corn-Soy Enzymes, Retention, Pullets

T28 Fermenting sludge from a broiler processing plant: Effect of different levels of cane molasses . R. Sanabria León*, S. Pagán Riestra, A. A. Rodríguez, H. Santiago, and M. Pagán, *University of Puerto Rico, Mayagüez Campus, Mayagüez, PR.*

An experiment was conducted to determine the optimum level of addition of cane molasses as carbohydrate source on the fermentation characteristics of sludge from a broiler processing plant (SBPP). The SBPP was inoculated with lactic acid-producing bacteria applied at 106 cfu/g of fresh material. Inoculated SBPP was mixed with 5 five levels of cane molasses (0, 5, 10, 20, and 30%, w/w), placed into 1 kg capacity silos fitted with valves for gas release, and maintained at room temperature (28-30°C). Three silos per treatment were opened after 6 fermentation periods (0, 4, 7, 9, 14 and 21 d) and silage was analyzed to determine pH, chemical composition, and fermentation products. A completely randomized design with a 4 (levels of cane molasses) x 6 (fermentation periods) factorial arrangement of treatments was used for the correspondent statistical analysis. Mean separation was performed by Bonferroni t-test. Control sludge had higher ($P < .05$) pH than SBPP fermented with cane molasses. Sludge treated with 10, 20 and 30% cane molasses had lower pH (4.46, 4.49, and 4.58, respectively) than SBPP ensiled with a 5% level during the complete fermentation period. Also, dry matter and organic matter were higher ($P < .05$), and crude protein was lower ($P < .05$) as the levels of cane molasses increased. For all fermentations, lactic acid production was higher ($P < .05$) for treatments containing 10, 20 and 30% cane molasses. Propionic acid content was lower ($P < .05$) for treatments with a 20 and 30% cane molasses as compared to the other mixtures. Butiric acid content was higher ($P < .05$) for a 5% cane molasses treatment than sludge with a 0, 10, 20, and 30%. These results suggest that it is possible to ferment SBPP using cane molasses as a carbohydrate source. Levels higher than 10% of the sugar did not result in a better fermentation.

Key Words: Sludge, Cane Molasses, Fermentation Characteristics

T29 The amino acid ideal pattern for Pekin ducks during early growing period. Y. Wang*, Z. Niu, and F. Liu, *Northwest Sci-Tech University of Agriculture & Forestry, Yangling, China.*

Five experiments were conducted to set up the ideal pattern of amino acid requirement of Pekin ducks. In experiment 1, the digestibility of some amino acids in the basal diet were determined, including lysine (Lys), methionine (Met), tryptophan (Trp), threonine (Thr), and isoleucine (Ile). In experiment 2, the growth performance was investigated to effect of different levels of Lys, Met, and Trp, and their interaction under a 3×3 factorial arrangement. The experiment 3 was conducted to evaluate the influence of different levels of Trp, Thr, and Ile, and their interaction. The experiment 4 was carried out to investigate the efficacy of different levels of Trp, Thr, and Ile in a lower protein-diet. In experiment 5, based on the results above, six amino acid models were used to test in order to select a ideal model. The results showed that Lys, Met, Trp, Thr, and Ile requirement of Pekin ducks during 0-2 week was 1.10%, 0.46%, 0.24%, 0.42%, and 0.53% resp., and the digestive amino acid requirement was 1.02%, 0.44%, 0.21%, 0.38%, and 0.47% resp. The total amino acid ideal pattern for duckling was: Lys:Met:Trp:Thr:Ile=100:41:21:38:48, and the digestive amino acid ideal pattern was: Lys:Met:Trp:Thr:Ile=100:43:21:37:46.

Key Words: Pekin Duck, Amino Acid, Ideal Pattern

Nonruminant Nutrition: Grow/Finish - Energy & Protein

T31 Advantages of formulating diets based on net energy on pig performance, carcass characteristics and production economics. M. Rademacher*¹ and L. Hagemann², ¹Degussa AG, Hanau, Germany, ²State Office for Consumer Protection and Agriculture of Brandenburg, Teltow, Germany.

The objective of this study was to determine the effect of dietary energy formulation system on performance, carcass quality and production cost. A total of 126 pigs were used in a three phase-feeding program (phase I: 32 to 50 kg, phase II: 50 to 80 kg, phase III: 80 to 112 kg) in the weight range 32 to 112 kg. Pigs were housed in groups of 14 on a partially slatted floor. Feed was offered ad libitum via a FIRE system (Feed Intake Recording Equipment). Water was provided from low pressure nipple drinkers. Wheat-barley-rye and soybean meal based diets were formulated. Within each growth phase (Phase I, II and III), three diets (A, B, C) were formulated to provide similar digestible amino acid contents. Diets A within each phase were formulated on ME basis and standard dietary CP levels. Diets B were reduced CP diets formulated on ME basis. Diets C were formulated to the same CP contents as Diets B but taking into account the net energy (NE) values of the ingredients. During the overall growing-finishing period, feed intake and feed efficiency were not affected ($P > 0.05$) comparing the 3 experimental groups. Growth rate was significantly affected ($P < 0.05$) with group B having a lower ADG compared with group C (836 vs 868 g/d) and group A (854 g/d) being intermediate. Lean gain of groups A, B and C was 422, 411 and 432 g/d ($P > 0.05$), respectively. The economic impact of comparing group A with group C resulted in a reduction in feed cost per pig by 0.63 EUR (30.62 vs 29.99 EUR), carcass value was improved by 1.10 EUR (109.63 vs 110.73 EUR) and carcass value minus feed cost was improved by 1.73 EUR per pig. Dietary CP can be reduced in growing-finishing diets without affecting growth rate, feed intake, feed efficiency and carcass quality as long as diets are formulated based on the NE concept in combination with digestible amino acids and limiting amino acids supplemented according to the ideal protein concept. This will further result in higher profit due to improved pig performance, better carcass quality and savings in feed costs.

Key Words: Pigs, Energy Systems, Performance

T32 The effects of dietary oil inclusion and oil source on apparent digestibility, fecal volatile fatty acid concentration and manure ammonia emission. A. G. B. Leek¹, V. E. Beattie², and J. V. O' Doherty*¹, ¹Department of Animal Science and Production, University College Dublin, Dublin, Ireland, ²Devenish Nutrition Ltd., Belfast, North Ireland.

An investigation was conducted to test the hypothesis that dietary oil inclusion increases ammonia nitrogen (NH₃-N) emission from the ma-

T30 Transgenic chickens expressing beta-galactosidase hydrolyze lactose in the intestine. S. Pophal*^{1,2}, P. Mozdziak¹, S. Borwornpinyo¹, and J. Petite¹, ¹North Carolina State University, Raleigh, ²Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

Chickens do not possess the necessary enzymes to efficiently hydrolyze lactose into glucose and galactose. The bacterial enzyme beta-galactosidase can convert lactose into glucose and galactose. Transgenic chickens that carry the E. coli lacZ gene and express beta-galactosidase could potentially employ lactose as an energy source. The objective of this study was to determine the ability of the small intestinal mucosa from transgenic chickens to hydrolyze lactose into glucose and galactose. Lactase activity was examined in the intestinal mucosa from wild-type chickens and two lines of chickens that carry the lacZ gene and express beta-galactosidase. Lactase activity was significantly ($P < 0.05$) higher in both transgenic lines compared to wild-type birds. The presence of the beta-galactosidase enzyme was revealed via X-gal staining in the intestine of transgenic chickens, while it was not present in the wild-type chickens. Overall, it appears that inserting the lacZ gene, which encodes beta-galactosidase has resulted in a chicken that can utilize lactose as an energy source. This study demonstrates that transgenic technology can be used to modify nutrient utilization in domestic poultry.

Key Words: LacZ, Lactase, Transgenic

nure, due to a negative effect of either unsaturated or saturated oil on microbial activity in the intestine. Dietary oil was included at 45 g/kg, as either crude palm oil (PO), soya oil (SO) or a 50:50 PO:SO blend (OB), to a basal barley-soya-wheat diet (control) at the expense of dextrose and maize starch. Diets were formulated to contain 13.2 MJ DE/kg and 11.0 g/kg lysine. Four boars were assigned to each dietary treatment, and were transferred to metabolism crates (mean live weight, 74.0 kg ± 2.89) following 14 days dietary acclimation. Urine and feces were collected separately over a 5-day digestibility/nitrogen (N) balance period and a 2-day manure collection period. Inclusion of dietary oil increased apparent digestibility of oil ($P < 0.01$) and decreased the apparent digestibility of dry matter ($P < 0.01$) and gross energy ($P < 0.05$). Dietary oil did not affect the apparent nitrogen, acid detergent fibre, neutral detergent fibre or hemicellulose digestibility. Apparent digestibility of oil was lower when oil was included as PO compared to SO and OB ($P < 0.001$). The concentration of faecal volatile fatty acid (VFA) was similar in all treatments, although the acetic:propionic acid was lower when oil was included as PO and OB compared to SO ($P < 0.05$). N balance, manure N concentration and NH₃-N emission was not affected by oil inclusion or oil source. In conclusion, dietary oil inclusion reduced apparent dry matter and energy digestibilities, although no effect on fermentation was indicated by digestibility of fibre or faecal VFA content. Consequently, ammonia emission was not affected by dietary oil included at 45 g/kg.

Key Words: Pigs, Oil, Ammonia

T33 Influence of lipid source in diets on the performance, meat quality and lipid profile for finishing pigs. R. V. de Sousa¹, E. T. Fialho*¹, J. A. F. Lima¹, P. V. R. Logato¹, and J. I. A. Leite², ¹University Federal of Lavras - UFLA- Brazil, ²University Federal of Minas Gerais-UFMG-Brazil.

Two experiments were conducted to evaluate lipid sources for finishing pigs. Exp. 1 utilized a total of 44 barrows and 44 gilts (LD × LW; 68.5 ± 1.45 kg BW) while Exp. 2 used a total of 66 hybrid barrows (33 with 73.65 ± 1.56 kg initial BW and 33 with 88.50 ± 1.11 kg initial BW). The experiments were conducted to evaluate different sources of lipids at 2% (soybean oil, canola oil, linseed oil and commercial PUFA oil) in Exp. 1 and different levels (2.0, 2.5, 3.0 and 3.5%) of canola oil in Exp. 2 upon lipid metabolism, growth, carcass characteristics and meat quality. Experimental diets were isocaloric, isoprotein and isolysinic, and formulated with corn and soybean meal as base ingredients. There were no effects of sources and levels of canola oil tested on the performance. However, lean meat percentage and longissimus muscle area was improved ($P < 0.01$) by the addition of 2% linseed oil in the diet. The pigs fed diets with linseed and canola oil had higher content of protein and ash in longissimus muscle in comparison with those fed diets with

soybean oil. The biceps muscle of animals fed diets with linseed oil had higher content of protein in the same tissue of animals fed soybean oil. The different levels (2.0, 2.5, 3.0, and 3.5%) of canola oil decreased linearly ($P < 0.01$) the level of ash in longissimus muscle. The fatty acid composition of intramuscular fatty of longissimus muscle reflected the dietary fatty acid composition. Blood lipids (total cholesterol, triglycerides and total cholesterol fractions [HDL, LDL and VLDL]) did not differ ($P > 0.10$) for the sources and levels of lipids added to the diets. In conclusion, the linseed oil at 2.0% in the finishing pig diet improved lean tissue accretion at the expense of lipogenesis. In addition fatty acid deposition follows the dietary fatty acids profile.

Key Words: Lipids, Oils, Cholesterol

T34 Utilization of pearl millet in substitution for corn in diets for growing pigs - metabolism assay and performance. E. T. Fialho*, M. da S. M. Pinheiro, J. A. F. Lima, P. B. Rodrigues, and R. T. F. de Freitas, *University Federal of Lavras - UFLA, Brazil.*

To evaluate the technical viability of substitution of corn by pearl millet in an isometric way for growing pig diets, two metabolism assays and one performance trial were conducted. The metabolism assays utilized 12 crossbred (LD x LW) barrows (31.8 ± 2.2 kg BW) for the feedstuffs (corn ground, whole pearl millet and ground pearl millet) and 10 barrows (42.1 ± 2.10 kg/BW) for diets with 0, 25, 50, 75 and 100% substitution of corn by ground pearl millet. A 7 d period for adaptation and 5 d period for total collection of feces and urine with ferric oxide (2%) as the indigestible marker was used for both metabolism assays. A total of 120 crossbred (LD x LW) barrows and gilts (30.7 ± 1.2 kg BW) were utilized in the performance trial. Pigs were allotted by weight and gender with five treatments (the same as used in the metabolism assay) and 12 replicates. The experimental unit was represented by the pen (1 barrow and 1 gilt/pen). The metabolism data from both whole and ground pearl millet revealed no differences ($P > 0.05$) for apparent digestibilities of nutrients or energy values; on average the DDM, ADCP, DP, DE and ME of pearl millet were 87.14%, 86.25%, 11.49%, 3166 kcal/kg and 3040 kcal/kg, respectively. The substitution of pearl millet at 100% for corn did not affect ($P > 0.05$) the digestibility coefficients of CP or nitrogen retention. But the digestibility coefficients of DM, as well as the dietary DE and ME values decreased linearly ($P < 0.01$) as corn was substituted by pearl millet. The performance data did not show any effects ($P > 0.05$) by totally replacing corn with pearl millet in the diet (ADG, kg - 100% corn 0.872 vs 100% pearl millet 0.889; ADFI, kg - 100% corn 2.30 vs 100% pearl millet 2.38; Feed/gain - 100% corn 2.67 vs 100% pearl millet 2.69). In conclusion, it is technically feasible to substitute up to 100% of corn with pearl millet in an isometric way for growing pigs from 30 to 60 kg.

Key Words: Swine, Pearl Millet, Corn

T35 Energy, protein, and amino acid digestibility in different sources of rice bran for growing pigs. C. Kaufmann¹, W. Sauer¹, M. Cervantes², M. Rademacher³, and J. He¹, ¹University of Alberta, Edmonton, AB, Canada, ²Universidad Autónoma de Baja California, Mexicali, Mexico, ³Degussa-Huls AG, Hanau-Wolfgang, Germany.

A study was conducted to determine the fecal GE digestibility and apparent ileal digestibilities (AID) of AA in five samples of rice bran (RB). Six barrows (36.5 kg average initial BW) fitted with a simple T-cannula at the distal ileum were used according to a 6 x 6 Latin square design. Five different sources of RB were evaluated: RB 1: Canadian source; RB 2: Riceland Foods Inc., Stuttgart, AR, US; RB 3: Italy; RB 4: Phillipines; and RB 5: Agribbrands/Tradico, Greenville, MS, US. Six diets were formulated to contain 18% CP. Diets A, B, C, D and E contained 53.8% corn, 19.9% soybean meal (SBM) and 23.1% of each RB source. Diet F (reference diet) contained 71.03% corn and 26.3% SBM. The fecal energy digestibility of RB 4 (86.9%), which was the lowest in NDF content, was higher ($P < 0.05$) than those of RB 1, 2, 3, and 5 (60.5, 64.1, 62.6, 65.8%, respectively). The AID of CP and AA in RB 1, 2, 3, 4, and 5 were: CP, 61.3, 38.3, 48.3, 65.3, 67.3; Arg, 85.1, 75.7, 79.7, 83.1, 83.3; His, 81.7, 66.0, 75.8, 79.8, 76.7; Ile, 73.2, 53.9, 67.7, 73.4, 72.0; Leu, 72.0, 50.9, 63.7, 73.5, 67.2; Lys, 82.2, 62.6, 72.7, 70.5, 73.1; Met, 76.0, 61.4, 66.9, 72.2, 74.0; Phe, 71.9, 52.5, 65.2, 76.8, 70.6; Thr, 82.8, 58.4, 73.9, 86.1, 75.9; Val, 76.2, 60.2, 71.1, 76.9, 75.3; Trp, 82.6, 58.8, 69.7, 70.0, 73.3, respectively. There was considerable variation in

the amino acid digestibilities among the RB samples. The ileal CP and amino acid digestibilities were lowest in RB 2, a defatted source of RB. The values for amino acid digestibility were highest in RB 4 (which has the lowest NDF content), in RB 5 (an extruded source of RB), and RB 1. There were significant relationships ($P < 0.05$) between the content of fat (positive), or CP (negative) and the AID of Lys and Trp. No significant correlations were observed between the NDF or ash contents and the AID of AA. This study shows that there is considerable variation in fecal GE, and CP and AA apparent ileal digestibility values in RB, and that it is rather difficult to specify an overriding factor responsible for the variation.

Key Words: Rice Bran, Pigs, Digestibility

T36 Comparison of growing swine performance when fed diets containing cull chickpeas in substitution of soybean meal and corn. J.F. Obregon, J.M. Uriarte*, R. Barajas, and H.R. Guemez, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico.*

To determine the effect of substitution of soybean meal and corn for cull chickpeas on growth performance and carcass traits in finishing pigs, 72 pigs (BW = 27.48 ± 0.97 kg; Large White x Landrace x Large White x Pietrain) in groups of six were placed in 12 concrete floor pens (1.5 x 6 m). Pens were fed one of three diets: 1) Diet with 17.2% CP and 3.36 Mcal ME/kg, containing corn 73%, soybean meal 23%, and premix 4% (CONT); 2) Diet with 17.1% CP and 3.35 Mcal ME/kg with corn 60.5%, cull chickpeas 20%, soybean meal 15.5%, and premix 4% (CHP20), and 3) Diet with 17.1% CP and 3.33 Mcal ME/kg with corn 47.2%, cull chickpeas 40%, soybean meal 8.8%, and premix 4% (CHP40). Pig were weighed at days 0 and 45 of the experiments and feed intake was recorded daily; ADG and feed intake/gain ratio were calculated from these data. Body weight at day 45 (59.41, 61.62 and 58.51 kg) were not affected ($P = 0.16$) by CONT, CHP20 and CHP40, respectively. ADG (0.71, 0.75 and 0.69 kg) was similar ($P = 0.15$) between dietary treatments. Feed intake (1.83, 1.90 and 1.89 kg) was not modified ($P = 0.13$) by treatments. Feed/gain ratio (2.58, 2.53 and 2.67) was similar ($P = 0.33$) between treatments. It is concluded, that cull chickpeas can be used up to 40% in diets for growing pigs without affecting growth performance.

Key Words: Chickpeas, Growth Performance, Pigs

T37 Effect of the substitution of soybean meal and corn for cull chickpeas in the diet on growth performance and carcass traits of finishing pigs. J. F. Obregon, H. R. Guemez*, F. G. Ríos, R. Barajas, and J. M. Uriarte, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Masatlan, Mexico.*

To determine the effect of substitution of soybean meal and corn for cull chickpeas in the diet growth performance and carcass traits of finishing pigs, 72 pigs (BW = 62.81 ± 2.63 kg; Large white x Landrace x Large white x Pietrain) in groups of six were placed in 12 concrete floor pens (1.5 x 6 m). Pens were fed one of three diets that consisted of the treatments: 1) Diet with 13% CP and 3.88 Mcal ME/kg, containing corn 81.7%, soybean meal 14.3% and premix 4% (CONT); 2) Diet with 13.1% CP and 3.34 Mcal ME/kg with corn 61.7%, cull chickpeas 30%, soybean meal 4.3% and premix 4% (CHP30), and 3) Diet with 15.1% CP and 3.30 Mcal ME/kg with corn 36%, cull chickpeas 60% and premix 4% (CHP60). Pigs were weighed at days 0 and 42 of the experiment and feed intake was recorded daily; ADG and feed/gain ratio were calculated from these data. After 42 days eight pigs from each treatment were killed in a slaughterhouse and carcass traits measured. Body weight at day 42 (92.33, 92.45 and 91.49 kg) was not affected ($P = 0.80$) by CONT, CHP30 and CHP60, respectively. ADG (0.721, 0.723 and 0.698 kg) were similar ($P = 0.84$) between dietary treatments. Feed intake (2.67, 2.69 and 2.56 kg) was not modified ($P = 0.35$) by treatments. Feed/gain ratio were similar ($P = 0.42$) between treatments. Hot carcass weight (81.37, 79.37 and 77.56 kg) was similar ($P = 0.26$) and carcass yield was not affected ($P = 0.35$) by the treatments. Back fat (1.64, 1.46 and 1.60 cm) were not affected ($P = 0.42$), rib eye area, weights of loin and leg was similar ($P = 0.39$). It is concluded, that cull chickpeas can be used up to 60% in diets for finishing pigs without affecting performance and carcass traits.

Key Words: Chickpeas, Carcass Traits, Pigs

T38 Effect of diets formulated based on ileal lysine digestibility and alternative feeds for finishing pigs - metabolism and performance assay. M. L. F. Silva, E. T. Fialho*, J. A. F. Lima, R. V. de Sousa, and L. D. S. Murgas, *University Federal of Lavras - UFRA-Brazil*.

Two experiments were conducted to evaluate the digestibility of dietary nutrients, performance and carcass characteristics of pigs fed finishing diets based on corn, soybean meal and alternative ingredients with the same total dietary content of true digestible lysine (NRC, 1998). The treatments in both experiments were: T1 diet formulated with corn and soybean meal; T2 corn, soybean meal, peanut meal solv. and cottonseed meal solv. 41% CP; T3 - corn, soybean meal, meat and bone meal 45% CP, and fish meal 60% CP; T4 sorghum, defatted rice bran and soybean meal. The metabolism assay used 24 barrows (62 kg BW). A 7 d period for adaptation and 5 d period for total collection of feces and urine with ferric oxide (2%) as the indigestible marker was used. In the performance assay, 64 commercial hybrid barrows (61.9 ± 3.10 kg BW) were used. The pigs were housed in pairs in pens with pen as the experimental unit. For the two assays, a total of 6 and 8 replications were used, respectively. The apparent fecal digestibility of DM, nitrogen retention, as well as DE and ME of the diets did not differ (P>0.05) among the treatments tested. However, the digestibility of CP was better (P<0.05) for T2 (86.65%) and T3 (87.24%) than T1 (85.78%) and T4 (85.82%). The performance of finishing pigs as well as the carcass characteristics did not differ (P>0.05) for the diets tested. In conclusion diets for finishing pigs formulated with alternative feeds and based on the same amount of true digestible lysine have been shown to be technically viable.

Key Words: Performance, Digestible Lysine, Metabolism Assay

T39 Energy and protein values of some Brazilian feedstuffs for pigs as determined by metabolism assay. E. T. Fialho*, Z. A. S. Santos, J. A. F. Lima, R. T. D. Freitas, and A. G. Bertechini, *University of Lavras-UFLA, Brazil*.

Assays were conducted to determine the chemical composition and digestibility of protein and energy of 16 Brazilian feedstuffs in growing pigs. Five metabolism trials were conducted with a total of 60 LDxLW barrows (40.4 ± 2.2 kg). During each trial, pigs were penned individually in stainless steel metabolism cages with a 7 d period for adaptation and 5 d period for total collection of feces and urine. Ferric oxide (2%) was utilized as the indigestible marker. The basal diet was an 18% CP corn-soybean meal diet in each metabolism assay. The experimental diets consisted of 70% basal diet plus 30% of the test feedstuff, except for the oils and lards which were added at 15% for evaluation. In each metabolism trial three feeds plus the basal diet were tested. Digestible protein and digestible and metabolizable energy values were calculated by using the Matterson et al., 1968 (Agric. Exp. Station Research Report, Univ. Connecticut) equation. These data indicate that there are differences in digestibility protein and energy among Brazilian feedstuffs in relation to those referenced by the foreign feed composition tables (NRC, 1998 and Feedstuffs, 2003). We conclude that reliable estimates of digestibility values can significantly improve the precision of pigs diets formulation.

Chemical composition and digestibility of protein and energy of some Brazilian feedstuffs determined by metabolism assays¹

FEED-STUFFS	DM, %	CP, %	NDF, %	ADF, %	CP Digest, %	DE, kcal/kg	ME, kcal/kg
Cottonseed Meal	89.10	32.1	28.4	17.4	66.2 (2.3)	2480 (60)	2190 (77)
Bakery Residue Meal	89.3	8.4	10.4	9.3	84.4 (2.5)	3220 (76)	3185 (69)
Coconut, Lard	99.4	-	-	-	-	8110 (86)	7960 (78)
Soybean Meal, 46%	88.6	46.3	13.4	9.6	86.5 (2.1)	3430 (56)	3360 (79)
Soybean Meal, Micronized	89.3	37.1	10.6	9.1	86.8 (2.3)	4580 (73)	4350 (56)
Yellow Corn Ground	87.6	8.0	9.8	3.0	85.3 (1.2)	3480 (65)	3320 (59)
Pearl Millet Ground	87.0	11.6	20.7	11.7	86.2 (1.6)	3213 (62)	3048 (72)
Swine, Lard	99.3	-	-	-	-	8540 (84)	8280 (86)
Citrus Pulp	91.1	6.3	40.8	13.2	60.8 (3.3)	2367 (89)	2096 (87)
Milk dried skim	90.2	31.2	-	-	90.4 (2.7)	4560 (67)	4450 (78)
Peanut Meal	92.2	49.6	11.54	9.72	81.2 (3.4)	3292 (84)	3146 (90)
Sunflower Meal	92.7	2.5	43.6	32.9	77.7 (1.7)	2365 (54)	2289 (54)
Wheat Meal	87.7	15.1	40.2	12.5	74.9 (2.7)	2515 (67)	2358(72)
Cassava Meal	87.8	2.2	8.7	5.2	78.3 (3.0)	3225 (100)	3097 (87)

¹Data on as fed basis.

Key Words: Digestibility, Swine, Metabolism Assay

T40 Comparison of a diet containing food waste with a corn/soybean diet fed to swine. J. Jones, M. L. Westendorf*, and J. E. Wohlt, *Rutgers, The State University of New Jersey, New Brunswick*.

Recycled food waste can provide an acceptable and nutritious feed for swine. Although pigs will readily consume wet food waste, the high moisture content contributes to spoilage and feeding management problems. The use of a dry, processed food waste product was compared to a traditional corn/soy diet using growing swine in two performance trials and one digestibility trial. The food waste diet contained 30-35% processed food waste on a dry matter basis. In Trial 1, 24 gilts (76.4 kg) were fed in a six-week trial. Intake, gain, feed efficiency, and carcass characteristics were compared. Feed intake and gain averaged 3.4 and 3.6 kg of DM/d and .87 and .85 kg/d for gilts fed traditional and food waste diets, respectively. There were no differences in these or any other measurements (P#88050.05). In Trial 2, 12 barrows (84.3 kg) were fed in a six-week trial. Intake, gain, feed efficiency, and carcass characteristics were compared. Feed intake and gain averaged 3.1 and 3.3 kg of DM/d and .62 and .71 kg/d for barrows fed traditional and food waste diets, respectively (P#88050.05). There were no differences in carcass characteristics (P#88050.05) except in Trial 2 when belly weight in food waste-fed pigs was greater (P#88040.05) than control pigs (10.7 vs 9.6 kg). In Trial 3, four growing gilts (68.2 kg) were used to compare digestibility in a crossover design. There were no differences (P#88050.05) for DM, CP, ADF, or NDF digestibility when feed intake averaged 1.9 kg of DM/d for both food waste and corn/soy diets. The use of up to 35% processed food waste may be suitable in commercial swine diets.

Key Words: Food Waste, Wheat Middlings, Growing Pigs

T41 Evaluation of protein dispersibility index as an indicator for soybean meal protein quality in growing pigs: II. Feeding trial. H. S. Lee*¹, J. G. Kim², Y. W. Shin², Y. H. Park², and K. Y. Whang², ¹*American Soybean Association, Seoul, Korea*, ²*Korea University, Seoul, Korea*.

A 42-d feeding trial was conducted to verify the plausibility of using the protein dispersibility index (PDI) as an indicator of soybean meal protein quality. Soy flake treatments (Trt) used in this experiment were: 1) raw; 2) steamed for 5 min at 95°C; 3) 5 min at 110°C; 4) 15 min at 110°C; and 5) 60 min at 110°C. A total of 120 pigs (YxLxD) weighing 12.2 ± 0.8 kg were assigned to five dietary treatments with 6 replicates. Experimental diets containing various heat-treated soy flakes included 3390 kcal/kg ME, 19.1% CP, and 1.05% lysine. The ADG of Trt 4 was

higher ($P < .05$) than those of Trt 1, 2, and 5. Feed efficiency (G/F) and feed intake of pigs in Trt 1 were lower ($P < .05$) than those in other treatments. Although pepsin digestibility and urease activity index were not correlated with growth performance, the KOH protein solubility and PDI measurements were highly correlated with ADG ($r^2 = 0.659$, $P < .001$ and $r^2 = 0.649$, $P < .001$, respectively) and G/F ($r^2 = 0.719$, $P < .001$ and $r^2 = 0.739$, $P < .001$, respectively). These results suggest that PDI is as effective as KOH protein solubility as an indicator of soybean meal protein quality in growth performance of growing pigs.

Treatments	ADG, g	ADFI, g	G/F
1	323.75 ^c	847.63 ^c	0.38 ^b
2	554.81 ^b	1038.99 ^b	0.54 ^a
3	583.34 ^b	1040.91 ^b	0.56 ^a
4	625.13 ^a	1127.73 ^a	0.55 ^a
5	550.44 ^b	1062.71 ^{ab}	0.52 ^a
SEM	15.64	30.33	0.02
P-value	0.001	0.001	0.001

Key Words: Pigs, Protein Dispersibility Index, Growth Performance

T42 Evaluation of protein dispersibility index as an indicator for soybean meal protein quality in growing pigs: I. Metabolic study. H. S. Lee^{*1}, Y. W. Shin², J. G. Kim², Y. H. Park², and K. Y. Whang², ¹American Soybean Association, Seoul, Korea, ²Korea University, Seoul, Korea.

Five differently heat-treated soy flake treatments (Trt), 1) raw; 2) steamed for 5 min at 95°C; 3) 5 min at 110°C; 4) 15 min at 110°C; and 5) 60 min at 110°C, were prepared and used as a major dietary protein source to verify the plausibility of using protein dispersibility index (PDI) as an indicator of soybean meal protein quality in a nitrogen balance trial with growing pigs. Twenty castrated pigs (Y×L×D) weighing 14.1 ± 0.9 kg were randomly assigned to dietary treatments and fed experimental diets containing various heat-treated soy flakes. Pigs were adjusted for three days prior to fecal and urinary sample collection for four days. Pigs fed the diet containing soy flake heat-treated for 15 min at 110°C (Trt 4) had the highest nitrogen retention among pigs in this experiment. Nitrogen retention was increased as the heat-treatment was applied from Trts 1 to 4, and then decreased in Trt 5. Both KOH protein solubility ($y = -0.0153x^2 + 1.9191x + 13.957$, $r^2 = 0.893$, $P = 0.001$) and PDI measurements ($y = -0.0067x^2 + 0.3033x + 66.2127$, $r^2 = 0.841$, $P < 0.001$) were correlated with the nitrogen retention of the pigs. It is found however that urease activity index and pepsin digestibility were not correlated with nitrogen retention in this experiment. This result suggests that PDI is as effective as KOH protein solubility as an indicator of soybean meal quality in nitrogen retention of growing pigs.

Treatments:	1	2	3	4	5	SEM	P-value
Urease activity	1.95 ^a	0.10 ^b	0.02 ^c	0.03 ^c	0.01 ^c	0.01	0.001
Pepsin dig., %	95.25	95.07	94.72	94.54	93.29	0.62	NS
KOH prot. sol., %	96.12 ^a	84.78 ^b	79.06 ^c	76.99 ^d	41.70 ^e	0.54	0.001
PDI, %	65.37 ^a	33.75 ^b	22.59 ^c	21.10 ^c	8.64 ^d	0.45	0.001
N retention, %	57.49 ^c	67.21 ^b	69.86 ^{ab}	71.64 ^a	67.46 ^b	0.95	0.001

Key Words: Pigs, Protein Dispersibility Index, Nitrogen Retention

T43 Effects of altering bed depth in the desolventizer/toaster used in soybean meal preparation on nutrient digestibility by ileally cannulated pigs and cecectomized roosters. L. Pope^{*}, K. Bruce, L. Karr-Lilienthal, C. Grieshop, N. Merchen, C. Parsons, and G. Fahey, *University of Illinois, Urbana.*

Soybean meal (SBM) has been a major contributor of dietary amino acids for the poultry, swine, and aquaculture industries for many years, and it is widely known that processing conditions used to prepare SBM have an impact on its nutrient composition. In an attempt to determine

the optimal processing conditions for preparation of SBM that maximize amino acid digestibilities, six lots of high protein SBM were produced under different toasting conditions. Specifically, the bed depth in the desolventizer-toaster was varied (4.0, 4.5, 5.5, 6.0, 7.0, and 8.0 in.). All soybeans were acquired from the same producer, and the preparation and extraction conditions were held constant for all lots. The SBMs then were incorporated into semipurified diets and fed to ileally cannulated pigs in a 7 × 7 Latin Square design to determine ileal and total tract nutrient digestibility. A low-protein casein diet also was fed to estimate endogenous losses of amino acids, and to allow for an accurate determination of true amino acid digestibilities. Each experimental period was seven days, with a five-day adaptation period and a two-day ileal collection. The SBMs were also fed to cecectomized roosters in order to determine true amino acid digestibilities by poultry. When fed to pigs, there were no differences ($P > 0.05$) among treatments in apparent or true ileal lysine digestibilities, with values ranging from 87.3 to 90.2% and 90.7 to 93.5%, respectively. Additionally, there were no differences ($P > 0.05$) in ileal apparent or true total amino acid digestibilities, but the dietary amino acids were highly available (true average total amino acid digestibility = 92.2%). For cecectomized roosters, no differences ($P > 0.05$) were observed in true lysine digestibility with values ranging from 83.2 to 87.0%. Alteration of the bed depth in the desolventizer-toaster had little effect on nutrient digestibilities of SBM by swine and poultry.

Key Words: Swine, Soybean Meal, Poultry

T44 Utilization of sunflower meal in diets of finishing pigs - performance and digestibility. D. de C. Carellos, J. A. F. Lima, E. T. Fialho^{*}, R. T. F. Freitas, and E. P. Filgueiras, *University Federal of Lavras, UFLA, Brazil.*

The objective of this study was to evaluate the influence of increasing levels of solvent extracted sunflower meal (SFM - DM 92.71%, CP 27.50%, NDF 43.57%, ADF 32.96%, CF 25.91%, EE 3.08%, GE 4,390kcal/kg) on the digestibility, performance and carcass characteristics of finishing pigs. A total of two experiments were conducted. The metabolism trial was conducted to evaluate the digestibility of Dry Matter (DDM), crude Protein (DCP), gross Energy (DGE) and fiber detergent neutral (DFDN) of SFM nutrients in diets containing 0, 4, 8, 12 and 16% SFM by utilizing 15 crossbred barrows (LD × LW; 55.1 ± 4.8 kg). The experimental unit was represented by the metabolism cage. A 7 d period for adaptation and 5 d period for total collection of feces and urine with ferric oxide (2%) as the indigestible marker was used. The digestibility values for SFM (as fed basis) were 54.40% DM, 77.73% CP, and 53.80% GE resulting in a digestible nutrient content of 50.43% DDM, 21.38% DCP, 2,365 kcal/kg DE and 2,289 kcal/kg ME. A linear effect ($P < 0.01$) was found for DDM and DFDN, a quadratic effect ($P < 0.01$) for DGE (higher value with 13.5% of SFM), DCP (higher value 11.55% of SFM) and NR (higher value 17.45% of SFM). In the performance trial, 80 crossbred pigs (LD × LW; 62.0 ± 4.2 kg BW) were utilized. Pigs were allotted by weight and gender to treatment and replicate. The experimental unit was represented by the pen (1 barrow and 1 gilt/pen). The five dietary treatments were increasing levels of SFM (0, 4, 8, 12 and 16%). At the end of the performance trial (99.80 ± 6.91 kg), the pigs were slaughtered for carcass evaluation. The increasing levels of SFM resulted in a linear decrease ($P < 0.05$) for feed intake. In carcass evaluation, the increasing levels of SFM inclusion did not affect ($P > 0.05$) any variable evaluated. However, it was found that the barrows had higher P2 values, carcass weight and percentage carcass lean, and the gilts had greater ham weight. It was concluded that inclusion levels of SFM up to 16% in a isonutritive diet should be technically feasible for finishing pigs from 65 to 98 kg BW.

Key Words: Sunflower Meal, Pigs, Byproduct

T45 Effect of dry skim milk on fecal bacterial populations and *Salmonella* shedding in growing-finishing swine. J. E. Wells^{*}, J. T. Yen, and D. N. Miller, *USDA-ARS; U.S. Meat Animal Research Center, Clay Center, NE.*

Dry skim milk (DSM) contains approximately 55% lactose and lactose has been suggested to have prebiotic effects in the mammalian digestive system. Barrows were fed growing, growing-finishing, and finishing diets from age 10-14 wk, 14-18 wk and 18-22 wk, respectively. For each feeding phase, diets were formulated to contain 0 or 10% DSM (balanced with ME and apparent ileal digestible AA). Animals were weighed every

two wk. DSM did not alter animal gain, feed intake, or feed conversion ($P>0.05$). Fecal samples were collected from 40 animals (20 with DSM and 20 without DSM) at wk 10 (d 0 on diets), 14, 18, and 22, and were analyzed for *Lactobacillus* sp. (LAB), Enterobacteriaceae (EB), coliforms (CF), generic *Escherichia coli* (EC), and *Salmonella* sp. At week 10, fecal bacterial counts (\log_{10} CFU/g feces) were 9.55, 7.26, 7.01, and 6.93 for LAB, EB, CF, and EC populations, respectively. The EB, CF, and EC populations decreased through wk 14 and 18 ($P<0.05$), but were still higher with the DSM diet ($P<0.05$). The LAB population decreased over time in the absence of DSM in the diet, whereas DSM sustained higher LAB counts ($P<0.05$). At wk 22, populations of EB, CF, and EC were higher ($P<0.05$) than wk 18 for the diet without DSM, but no change was observed with DSM. As a result, no differences between the diets were observed at week 22. *Salmonella* were detected in 70% of the animals at wk 10 and 14, but only 20% at wk 18 and 22. DSM did not affect *Salmonella* shedding, but pooled analysis indicated that fewer recurring incidences of *Salmonella* shedding occurred in animals with higher LAB bacteria. Nonetheless, weight gain for individual animals was not affected by *Salmonella* shedding in this study. It is concluded that 10% DSM affects fecal bacterial populations, but not *Salmonella* shedding in growing-finishing pigs.

Key Words: Gut and Microbes, Dry Skim Milk, Swine

Nonruminant Nutrition: Grow/Finish - Minerals & Additives

T47 Response of pigs to dietary phytase and calcium-to-phosphorus ratio. J. A. Jendza^{*1}, R. N. Dilger¹, M. R. Bedford², and O. Adeola¹, ¹*Animal Sciences, Purdue University, West Lafayette, IN*, ²*Zymetrics, Golden Valley, MN*.

Pigs were fed corn-soybean meal-based basal diets containing 0.71% Ca and 0.40% P to determine response to phytase and Ca-to-total P ratio (Ca:tP) in two 4-wk experiments. Pigs were blocked by weight and gender such that the average weight across treatments was similar with 1 barrow and 1 gilt receiving each treatment within each block, housed in individual pens, and allowed ad libitum access to diets and water. In Exp. 1, 48 10-kg crossbred pigs were used to evaluate the efficacy of an experimental microbial phytase. Diets consisted of the basal, basal plus 3.4 or 6.7 g/kg monosodium phosphate (MSP), basal plus 500 or 1,000 phytase units (FTU)/kg of the experimental or control phytase, and a positive control with adequate Ca and P. Supplemental MSP resulted in linear increases in wk 1 ADFI ($P < 0.05$), ADG in all periods ($P < 0.05$), final weight and ASH ($P < 0.0001$). Experimental phytase increased percent bone ash (ASH), apparent P digestibility ($P < 0.0001$), final weight, overall ADG, wk 4 ADG and wk 4 ADFI ($P < 0.05$). Bone ash (51.1%) in the 1,000 FTU experimental phytase/kg diet was similar to the 6.7 g/kg MSP diet (51.5%). Control phytase improved ASH and apparent P digestibility ($P < 0.01$). In Exp. 2, 48 11-kg crossbred pigs, were randomly assigned to treatments in a 3 x 2 factorial arrangement. The respective factors were Ca:tP (1.8, 1.5, or 1.2) and supplemental experimental phytase (0 or 1,000 FTU/kg). Phytase increased ($P < 0.01$) average BW at 2, 3 and 4 wk; ADG at 2, 3, 4 wk and overall; ADFI at 4 wk and feed efficiency (G:F). Lowered Ca:tP improved ($P < 0.05$) BW and ADG in all periods; ADFI at 3, 4 wk and overall; and G:F at 2, 3, 4 wk and overall. Interaction was significant for ADFI at 3, 4 wk and overall ($P < 0.05$). Results indicate that the experimental phytase is effective at liberating phytate P for uptake and utilization, while decreasing Ca:tP from 1.8 to 1.2 improves ADG, ADFI and G:F.

Key Words: Phosphorus, Phytase, Pig

T48 Growth performance and meat quality changes from trace mineral manipulation of finishing pig diets. B. V. Lawrence^{*}, D. Overend, S. A. Hansen, J. D. Hahn, and J. Hedges, *Hubbard Feeds Inc., Mankato, MN*.

A total of 257 terminal Duroc cross gilts (Compart Boar Store Line 442 X D100; 32.5 ± 1.9 kg) were compared between 2 treatments: a corn-soybean meal control diet (CTRL), or the CTRL diet for 63-d followed by the CTRL diet supplemented with Yield Pak (a blend of vitamins and trace minerals, YPC) from day 63 - 91. Pens ($n = 6$) were weighed on d-0, 63 and 91. Gain and gain:feed during the 91-d was not different between treatments despite the YPC pigs having higher ($P<0.05$)

T46 Metabolizable energy value of meat and bone meal for pigs. S. A. Adedokun^{*} and O. Adeola, *Purdue University, West Lafayette, IN*.

The metabolizable energy (ME) values of six samples of meat and bone meal (MBM) were determined in barrows. Twenty four pigs with an average weight of 34 kg were used for each of the MBM samples. The gross energy (GE), crude protein (CP), fat, and ash contents of the MBM samples ranged between 3.49 to 4.75 kcal/g, 44.81 to 61.38%, 8.44 to 13.27%, and 18.87 to 35.37%, respectively. The CP and GE of diets ranged from 17.6 to 19.2% and 4.26 to 4.44 kcal/g, respectively. Each diet was randomly assigned to each block of three crates giving a total of eight blocks for each sample of MBM. Diets were formulated by replacing the same ratio of corn and soybean meal in the basal diet with MBM at 0, 5, or 10%. The digestibility assay employed a 5-d acclimation followed by a 5-d period of total but separate collection of feces and urine. The ME of each of the MBM sample was calculated by regressing the MBM contribution to ME intake against amount MBM intake. The slope of the regression gave the ME content of the MBM sample. The ME of the MBM ranged from between 2.43 and 3.28 kcal/g. Meat and bone meal ME increased as both the GE and fat contents of the different MBM samples increased while MBM ME decreased with an increase in MBM ash content.

Key Words: Metabolizable Energy, Meat and Bone Meal, Pigs

intakes from day 63 - 91. At day 91, 80 gilts per treatment (116.2 ± 6.6 kg) were scanned using real-time ultrasound for 10th rib backfat and loin eye area as well as last rib fat. There was no effect ($P>0.10$) of YPC inclusion on carcass composition. A total of 40 gilts per treatment were individually tagged, tattooed, and weighed prior to shipment (123.0 ± 4.5 kg). After 8-h of transit to a commercial abattoir, live weights (119.7 ± 4.1 kg) and hot carcass weights (HCW) were obtained (91.9 ± 3.2 kg). Weight prior to shipment, abattoir live weight, and HCW were not different ($P>0.10$) between treatments. Fat and muscle depth and lean percentage were similar between treatments ($P>0.10$). Loin pH was measured at 1 and 22-h post-mortem and was not different at 1-h post-harvest, however, 22-h pH (5.62 vs. 5.70) was higher ($P<0.05$), and 22-h pH drop loss (0.49 vs. 0.60 units) lower ($P<0.05$) for the YPC pigs. At 22-h a 40 - 50 g loin core was taken between the 7th and 8th ribs and held for 7-d for determination of drip loss. The reduction in 22-h pH drop was associated with a tendency ($P<0.15$) toward a reduction in 7-d drip loss (3.93 vs. 4.86%). NPPC measures of loin color, firmness, and marbling, as well as ColorTec L*, A*, and B* values were not different ($P>0.10$) between the CTRL and the YPC pigs. The results of this experiment suggest that short term supplementation of the diet with an appropriate blend of vitamins and trace minerals may improve pig growth via stimulation of feed intake and may reduce drip loss via a reduction in the rate of post-mortem pH decline.

Key Words: Minerals, Pigs, Meat Quality

T49 Performance of pigs fed grain sorghum-based diets supplemented with phytase. J. Yáñez¹, M. Cervantes^{*1}, M. A. Barrera¹, W. Sauer², and N. Torrentera¹, ¹*Universidad Autónoma de Baja California, Mexicali, Mexico*, ²*University of Alberta, Edmonton, AB, Canada*.

An experiment was conducted to evaluate the effect of phytase supplementation to sorghum-soybean meal diets on the performance of growing pigs. Twenty-eight pigs (average initial BW 22.9 kg) were randomly distributed in 4 dietary treatments (7 replicates/treatment), according to a RB design. Treatments were: T1) sorghum-soybean meal, basal diet, 0.67% apparent ileal digestible lysine; T2) basal diet plus 350 units of phytase activity (FTU)/kg diet; T3) basal plus 700 FTU/kg diet; T4) basal diet plus 1 050 FTU/kg diet. All were formulated to contain 90% (0.77%) of the requirement of apparent ileal digestible lysine, and 100% the requirement of available phosphorus for pigs ranging in BW from 20 to 50 kg. All diets were supplemented with vitamins and minerals to meet or exceed the requirements for the 20 to 50 kg pigs. Daily weight gain (ADG), feed intake, lysine intake, threonine intake, and feed conversion for treatments 1 to 4 were: 0.67, 0.60, 0.61, 0.66 kg/d; 1.39, 1.29, 1.33, 1.47 kg/d; 12.4, 11.5, 11.9, 13.1 g/d; 9.3, 8.6, 8.9, 9.8 g/d; 2.09, 2.18, 2.17, 2.17. There was no effect of phytase supplementation on the

ADG ($P = 0.93$), feed intake ($P = 0.37$), lysine intake ($P = 0.37$), threonine intake ($P = 0.37$), or feed conversion ($P = 0.54$). However, pigs fed the diet supplemented with 350 FTU/kg tended to have a lower ($P = 0.10$) ADG as compared with the basal diet. The results from these experiments indicate that phytase supplementation does not affect the performance of pigs fed sorghum-soybean meal diets.

Key Words: Pigs, Sorghum, Phytase

T50 Paylean® did not compromise bone traits of finishing pigs fed diets formulated with phytase. C. E. Pardo*, J. N. Trower, D. K. Schneider, and T. D. Crenshaw, *University of Wisconsin, Madison.*

Improved performance of pigs fed ractopamine (Paylean®, Elanco Animal Health) is well established, but concerns have arisen over the combined use of Paylean and phytase in diets with no supplemental inorganic P (iP). The combination of Paylean and phytase (Natuphos®, 9400 G-concentrate, BASF) was evaluated in finishing pigs to determine if additional iP was required. One hundred twenty crossbred (D x LW x LR) pigs were initially (50.5 ± 0.4 kg) fed diets with phytase (0 or 500 FTU/kg) for 4 wk, then (82.0 ± 1.0 kg) fed one of five diets for an additional 4 wk. Diets provided Paylean (0 vs. 10 mg/kg, diets 1,2 vs. 3,4,5), phytase (0 vs. 500 FTU/kg, diets 1,3,5 vs. 2,4) and iP (0.45 vs. 0.65% total P, diets 1,3 vs. 5). Total lysine was increased from 0.70 to 0.90% in Paylean diets. As expected, ADG, feed efficiency, and carcass traits improved ($P < 0.05$) with inclusion of Paylean, but no benefits from iP were observed (data not shown). Metacarpal bone ash, percentage ash and mechanical properties (Force and Stress) were suppressed ($P < 0.06$) in pigs fed diets with phytase regardless of Paylean additions. Bone traits from pigs fed Paylean + phytase diets were compromised to the same extent as traits from pigs fed phytase without Paylean. The responses are consistent with a limitation due to phytase, but not Paylean. In pigs fed Paylean, additional iP improved bone traits ($P < 0.02$) over pigs fed diets with minimal P or phytase. In conclusion, growth, feed efficiency, carcass traits and bone traits of finishing pigs fed Paylean can be maintained with minimal supplemental P levels from either iP or phytase sources.

Dietary Treatments

Item	1	2	3	4	5	SEM
Paylean, mg/kg	0	0	10	10	10	
Phytase, FTU/kg	0	500	0	500	0	
P equivalents, %	0.45	0.45	0.45	0.45	0.65	
Ash, g ^{ab}	7.24	6.99	7.23	7.07	7.55	0.14
Ash, % ^{bcd}	59.6	58.5	59.5	59.0	60.7	0.2
Force, kg-cm ^{bcd}	78.6	68.1	79.0	77.6	84.5	3.2
Stress, kg/cm ^{2 cd}	2.62	2.28	2.57	2.53	2.91	0.12

^aBlk, $P < 0.05$; ^b3,4 vs. 5, $P < 0.02$;

^c1,2 vs. 3,4,5, $P < 0.06$; ^d1 vs. 2, $P < 0.06$;

^e3 vs. 4, $P < 0.05$.

Key Words: Bone, Ractopamine, Phosphorus

T51 Utilization of phytase in diets of growing pigs - ileal AA digestibility, performance and mineral excretion. H. O. Silva, E. T. Fialho*, J. A. F. Lima, L. D. S. Murgas, and R. T. F. de Freitas, *University Federal of Lavras - UFLA, Brazil.*

Exp. 1 evaluated the effect of level of phytase on the apparent ileal digestibility of protein and AA (AIDCP and AIDAA). The treatments were: T1- corn + soybean meal + defatted rice bran (DRB); T2 - corn + soybean meal; T3 - soybean meal + DRB; and T4 - soybean meal. All diets were supplemented with four levels of phytase (0, 400, 800 and 1200 FTU/kg diet from Natuphos 5000). Eight pigs with a simple T-cannula were used. The pigs were allocated to a 4 x 4 Latin Square design. Supplementation with phytase yielded a higher AIDCP and AIDAA of the diets, the level of 483 FTU/kg ($Y = 83.81 + 0.0029X - 0.000003X^2$,

$R^2 = 0.946$) was computed to yield the higher ileal digestibility values. These data show that phytase supplementation in the range of 440-900 FTU/kg diet is adequate in growing pig diets. Exp. 2 was designed to verify the effect of phytase on performance, bone mineralization and plasma urea content in growing pigs. A total of 80 crossbred (LD x LW; 30 ± 3.1 kg BW) barrows and gilts were allotted to four treatments and five replications. The treatments consisted of diets based on corn, soybean meal and DRB supplemented with four levels of phytase (0, 400, 800 and 1200 FTU/Kg). Over the 42 d experimental period, every eight days, blood of two animals per pen was collected. At the end of the experimental period, two animals were slaughtered for the collection of the metacarpal bone. Supplementation with the enzyme phytase up to the level of 1200 FTU/kg diet yielded a linear improved feed conversion and the content of Ca and P in the bone ($P < 0.05$). Phytase supplementation resulted in a quadratic effect on plasma urea and Mn ($P < 0.05$). It was concluded that supplementation with the enzyme phytase in growing pig diets should be beneficial as demonstrated by improved pig performance as well as increased bone mineralization of Ca, P and Mn. This would also contribute to the reduction of the environmental impact caused by pig excrement.

Key Words: Bone Mineralization, Phytase, Amino Acid Digestibility

T52 Use of betaine and conjugated linoleic acid as growth promotants in growing Iberian pigs. I. Fernandez-Figares*, I. M. Lachica¹, R. Nieto¹, E. Gonzalez Sanchez², and J. F. Aguilera¹, ¹Consejo Superior de Investigaciones Cientificas, ²Universidad de Extremadura, Spain.

Dietary betaine (BET) and conjugated linoleic acid (CLA) are associated with decreased lipid deposition and may improve feed efficiency in swine. We hypothesized that BET and/or CLA could have an impact as growth promotants on genetically unimproved purebred Iberian pigs. Gilts ($n=20$) were fed control, 1% CLA (CLA-60), 0.5% BET or 1% CLA+0.5% BET isoenergetic diets from 20 to 50 kg BW. Animals were fed diets containing 120 g crude ideal protein, and 15.4 MJ ME /kg DM at 80% of ad libitum intake. Dietary treatments and individual pen locations were assigned at random to experimental gilts. Pigs were weighed and feed intake was adjusted weekly according to BW. At 50 kg, pigs were electro-stunned, exsanguinated and organs were removed and weighed. Carcasses were chilled for 24 h to obtain carcass measurements. Fat depths along the midline and at P1, P2, P3 sites at 10th rib were determined. Compared to controls, pigs fed on BET+CLA had greater ($P < 0.05$) daily weight gain (602 vs. 540 g/day) although BET or CLA treatments were not different from control. Feed/Gain ratio was not influenced by the diets tested. Drip loss was increased when pigs were fed on the CLA+BET diet compared to control ($P < 0.05$; 2.39 vs 1.72%). There was a trend towards higher Loin Eye Area/EBW ratio when BET fed pigs were compared to controls ($P = 0.075$; 9.97 vs 8.83 cm²/kg). BET and BET+CLA fed pigs had 20% lower P1 than controls ($P < 0.05$). A nonsignificant 12% decrease in P2, P3, first rib, last rib, 10th rib back fat was observed in BET+CLA fed pigs compared to controls ($P > 0.10$). Livers from animals fed on BET+CLA were 17% heavier than controls ($P < 0.05$) while other organs were not affected by dietary treatments ($P > 0.10$). These preliminary data suggest that use of BET+CLA mixture is more effective than BET or CLA individually as growth promotants in growing Iberian gilts.

Key Words: Betaine, Conjugated Linoleic Acid, Iberian Pig

T53 Effects of dietary levels of tylosin on digestive and post-absorptive utilization of dietary nutrients in growing pigs. K. Bregendahl*, X. Yang¹, Y. Shen¹, G. Vessie², R. Bagg², T. C. Rideout¹, T. Archbold¹, P. Dick², and M. Z. Fan¹, ¹University of Guelph, Guelph, ON, Canada, ²Elanco Animal Health, Guelph, ON, Canada.

This study was conducted to examine effects of various dietary levels of tylosin on digestive and post-absorptive utilization of dietary crude protein (CP), calcium (Ca), and phosphorus (P) in growing pigs. Thirty-five Yorkshire barrows, with initial and final BW of 35 and 50 kg, were surgically fitted with a T-cannula, and fed five diets for five periods according to a completely randomized block design. The five diets were corn and soybean meal-based, and formulated to contain five levels of tylosin at 0, 11, 22, 44, and 110 ppm, respectively. Each experimental period lasted 25 d with 6-d adaptation and surgery, 6-d recovery, 10-d adaptation to diets, and 4-d collection of total urine excretion, and

digesta and fecal samples. Partitioned as the percentage of the total nutrient intake, post-absorptive metabolic urinary loss (19.1-25.1%) was the major route of N excretion followed by indigestible fecal loss, and the endogenous fecal loss (9.9-18.8%). Fecal loss (23.5-69.5%), and the post-absorptive metabolic urinary loss (0.4-1.1%) were the major routes of Ca losses. Fecal loss (37.7-67.7%), and the post-absorptive metabolic urinary loss (3.6-5.5%) were the routes of P losses. Orthogonal polynomial contrasts suggested that dietary levels of tylosin affected ($P < 0.05$) the nutrient retention through changing the nutrient losses at the ileal and the fecal levels but not ($P > 0.05$) at the post-absorptive urinary level. Dietary inclusion of tylosin at 11 ppm was optimal and improved ($P < 0.05$) the efficiency of digestive utilization of the nutrients and reduced ($P < 0.05$) the fecal excretion of these nutrients by about 10 percentage units. In conclusion, dietary supplementation of tylosin at 11 ppm resulted in the best efficiency of digestive utilization of the nutrients under the research environment. This optimal level of tylosin supplementation is likely to be affected by sanitary conditions.

Key Words: Growing Pigs, Nutrient Utilization, Tylosin

T54 Effects of dietary antibiotics on growth performance in pigs. J. W. Hong^{*1}, O. S. Kwon¹, B. J. Min¹, W. B. Lee¹, K. S. Son¹, J. H. Kim², B. C. Park³, and I. H. Kim¹, ¹Dankook University, Cheonan, Korea, ²Agribands Purina Korea, Inc., Seoul Korea, ³CTC Bio Inc., Seoul, Korea.

For Exp. 1, a total of 80 pigs (20.94 ± 0.85 kg average initial BW) were used in a 42-d growth assay to determine the effects of dietary chlortetracycline and sulfathiazole complex, oxytetracycline, and tylosin on growth performance in growing pigs. Dietary treatments included 1) CON (Basal diet : without antibiotic), 2) CTC (CON diet + 100 ppm chlortetracycline and sulfathiazole complex), 3) OTC (CON diet + 100 ppm oxytetracycline), 4) CTC+OTC (CON diet + 100 ppm chlortetracycline and sulfathiazole complex + 100 ppm oxytetracycline) and 5) TYL (CON diet + 44 ppm tylosin). For d 0-21, pigs fed TYL (471 g) diets had greater ADG than pigs fed CTC (366 g), OTC (416 g) and CTC+OTC (425 g) diets ($P < 0.04$). However, for the overall period, ADG, ADFI and Gain/feed were not significantly differences among the treatments. For the Exp. 2, a total of 80 pigs (52.04 ± 1.02 kg average initial BW) were used in a 42-d growth assay to determine the effects of dietary chlortetracycline and sulfathiazole complex, oxytetracycline and tylosin on growth performance in finishing pigs. Dietary treatments included 1) CON (Basal diet : without antibiotic), 2) CTC (CON diet + 100 ppm chlortetracycline and sulfathiazole complex), 3) OTC55 (CON diet + 55 ppm oxytetracycline), 4) OTC110 (CON diet + 110 ppm oxytetracycline) and 5) TYL (CON diet + 22 ppm tylosin). For the overall period, ADG of pigs fed CTC, OTC55, OTC110 and TYL diets were greater by 11% than pigs fed CON diet ($P < 0.03$). However, ADFI and Gain/feed were not significantly different among the treatments. In conclusion, the results obtained from these feeding trials suggest that dietary oxytetracycline and tylosin are an effective means of improving growth performance in growing and finishing pigs.

Key Words: Antibiotic, Growth, Pigs

T55 Effect of dietary natural herb extract (Biomate[®]) supplementation on growth performance, IGF-1 and carcass characteristics in growing-finishing pigs. O. S. Kwon^{*1}, B. J. Min¹, W. B. Lee¹, K. S. Son¹, J. H. Cho¹, J. H. Kim², I. H. Kim¹, and J. C. Ra³, ¹Dankook University, Cheonan, Korea, ²Agribands Purina Korea, Inc., Seoul, Korea, ³RNL Life Science Ltd., Korea.

A total of 86 pigs (LYD, 20.92 kg average initial BW) were used in a 112-d growth assay to determine the effects of dietary natural herb extract (Biomate[®]: extracts of growth promoter in *Artemisia capillaris*) on growth performance, IGF-1 of serum and carcass characteristics in finishing pigs. Dietary treatments included: 1) CON (basal diet; Control), 2) BM1 (basal diet with 0.02% of Biomate[®]), 3) BM2 (basal diet with 0.04% of Biomate[®]) and 4) BM3 (basal diet with 0.06% of Biomate[®]). Through the entire experimental period, as Biomate[®] increased, there was a decrease (linear, $P < 0.08$) in average daily feed intake and an increase (linear, $P < 0.02$; quadratic, $P < 0.08$) in gain/feed. Backfat thickness tended to decrease in pigs fed BM diets compared to pigs fed the CON diet (linear, $P < 0.09$; quadratic, $P < 0.01$). Increasing Biomate[®] tended to increase in IGF-1 content in serum (linear, $P < 0.09$). Hunter

a*(redness) (linear, $P < 0.01$) and b*(yellowness) (linear, $P < 0.02$) values of longissimus muscle were affected by the dietary Biomate[®] treatments. Color of longissimus muscle was higher in the dietary Biomate[®] treatments than pigs fed control diet (linear, $P < 0.03$). In conclusion, the results obtained from this feeding trial suggest that the Biomate[®] supplementation of diets for growing-finishing pigs can be improved growth performance, IGF-1 and meat quality.

Key Words: Pig, Herb Extract, Meat Quality

T56 Different isoflavone contents in soy-based diets are without influence on growth performance and carcass quality in pigs. G. Kuhn¹, K. Ender^{*1}, U. Hennig¹, C. Kalbe¹, S. Moors², G. H. Degen², and C. Rehfeldt¹, ¹Research Institute for the Biology of Farm Animals, Dummerstorf, Germany, ²University of Dortmund, Germany.

A weaner-grower-finisher performance trial with thirty-eight pigs was designed to compare the growth performance and carcass quality of pigs fed diets containing either soybean meal or soy protein concentrate in a pair-feeding design. Soybean meal (SM) and soy protein concentrate (SPC) differed in isoflavone (daidzein plus genistein) content (782 µg/g in SM and 125 µg/g in SPC, respectively). During the experiment, all pigs were fed four-phases-diets characterized by decreasing protein concentrations with increasing age (weaner I, weaner II, grower, finisher diets). Rations of control and experimental groups were isoenergetic, isonitrogenous, and isoaminogen. The weaning pigs with an initial live weight of 8.4 ± 1.1 kg were allotted to flat deck boxes. During the growing/finishing period (days 70 - 170 of age), the pigs were housed in single boxes. Both, the weaning and the grower/finishing performances (daily body weight gain, feed intake, feed conversion ratio) were similar in both groups. No differences were found between the groups in carcass composition (percentages of cuts, tissues, and protein/fat), and meat quality of pigs ($P > 0.05$). Moreover, the IGF-1R mRNA expression in longissimus muscle was not influenced by the kind of soy product ($P > 0.05$). However, circulating levels of isoflavones between pigs fed SM (genistein 239 ± 44; daidzein 162 ± 22; equol 12 ± 4 ng/mL plasma) and animals fed SPC (genistein 22 ± 9 and daidzein 8 ± 3, and equol 10 ± 3 ng/mL plasma) were clearly different (genistein: $P < 0.001$; daidzein: $P < 0.001$; equol: $P > 0.05$). The results confirm the expected differences in the bioavailability of soy isoflavones. Yet, there were no significant differences in performance of pigs fed either soybean meal or soy protein concentrate.

Key Words: Soybean Isoflavone, Pigs, Carcass Quality

T57 Effect of supplementation with natural tranquillizers in the diet of the pigs on the behavior of the animals and the technological quality of loin meat. M. Font i Furnols^{*}, N. Panella, E. Fàbrega, A. Velarde, M.A. Oliver, J. Soler, and M. Gil, *Institute for Food and Agricultural Research and Technology, Monells, Spain.*

Pork quality is greatly affected by the stress which pigs experience *ante mortem* (a.m.). This depends on the handling and behavior of the animal a.m., as well as on the genotype, especially the presence of the halothane gene (Hal). The aim of the project was to test, in nonstressful conditions, whether the diet supplemented with natural tranquillizers [magnesium (Mg) or tryptophan (Trp)] affected the technological quality of pork meat in two different genotypes [homozygous positive (nn) and negative (NN) for the Hal gene]. Thirty-six nn animals and 36 NN animals were reared with the same diet. However, 5 days before the harvest 12 pigs of each genotype were fed a diet supplemented with Mg (3.2 g elemental Mg per day), 12 pigs of each genotype a diet with Trp (12.5 g L-Trp per day) and the rest had no supplement in the diet (control pigs). Hot carcass weight was 78.1 ± 9.2 kg. Meat quality measurements and behavior observations of aversiveness to CO₂ stunning were taken. Diet and genotype effects were analyzed, the interaction being not significant ($P > 0.05$). The diet had no influence ($P > 0.05$) on any of the parameters of meat quality determined. However the pH measured at 45 minutes *post mortem* in the *longissimus* (LT) muscle was lower in nn than in NN animals ($P < 0.05$; 5.70 vs 6.45, respectively) and the electrical conductivity higher ($P < 0.05$; 7.34 vs 4.37 µS). There were no differences in the ultimate pH. The drip losses measured in LT were higher in nn than NN ($P < 0.05$; 10.13 vs 5.89). Both parameters showed that nn animals produced more exudative meat with implications of economical losses. There were no differences between genotypes and diets in the behavior

of the animals during the inhalation of CO₂. It can be concluded that, in a nonstressful a.m. treatment, the supplementation with elemental

Mg or Trp did not affect the meat quality parameters, the genetic of the animals being the most influential factor.

Key Words: Magnesium, Tryptophan, Pork quality

Swine Species

T58 Additional heat behind farrowing sows to reduce the number of stillborn piglets. Y. Gao, H. Y. Zhang, B. Szkotnicki, and R. R. Hacker*, *University of Guelph, Guelph, ON, Canada.*

Additional heat behind a sow at farrowing might help rendering a more relaxed labor in the sow and reduce the number of stillborn pigs at parturition. To examine the hypothesized heat effect, two trials were conducted. Parturient sows were moved to farrowing crates by day 109 of gestation, and fed a 14 (in trial I) or a 16% (in trial II) CP corn-soybean meal diet (3.2-5.5 kg) twice daily. The farrowing room was maintained at 21°C or above and the creep zone was maintained above 35°C with a 175W IR heat lamp. In total, 294 sows (86 Yorkshire in trial I and 208 Hay Bay F1 York/Landrace in trial II) were randomly assigned into either a Heat (an additional 100W IR heat lamp hovered behind the sow at farrowing) or a Non-Heat group. To distinguish stillborn pigs from other pigs that were born alive and died after birth, a lung flotation test was performed on all dead piglets after completion of farrowing. In addition, 20 sows (10 from each group) from trial I were observed for the farrowing behavior. The length of time sows spent sitting, standing and lying down, average delivery interval and position change frequency were recorded. Results showed that additional heat behind a sow at farrowing did not significantly reduce the number of stillborn pigs. On average, there was one stillborn piglet per litter for either the Heat or the Non-Heat group. However, Heat did appear to make live born piglets move readily to the sows udder. Furthermore, there was no difference between the Heat and the No-Heat group for the time farrowing sows spent lying down (85.8 vs. 85.8 min), sitting (9.5 vs. 10.1 min) or standing (4.6 vs. 4.2 min). Additional heat did not significantly decrease the average piglet delivery interval (16.9 min for the Heat group and 17.2 min for the Non-Heat group), however, it significantly decreased ($P < 0.05$) position change frequency (24 vs. 30 times). Less sow movement reduces the risk of the neonatal pigs being crushed by the sow.

Key Words: Additional Heat, Stillborn, Sow Farrowing Behavior

T59 Addition of heat at birth and supplementation of energy and IgG products on improving survivability in neonatal pigs. Y. Gao, H. Y. Zhang, B. Szkotnicki, and R. R. Hacker*, *University of Guelph, Guelph, ON, Canada.*

The objective of this study was to reduce piglet mortality during the first 7d of life by providing additional heat at birth and orally administering cream (C), (10% Half-and-Half cream, Parmalat Canada), and IgG, as Porcine plasma IgG concentrate (P), (American Protein Corp. Inc., IA, USA), to provide supplemental heat, energy and immunoglobulin to neonatal pigs. The farrowing room was maintained at 21°C or above and the creep zone was maintained above 35°C with a 175W IR heat lamp. In two trials, 294 litters (86 litters from Yorkshire sows in trial I and 208 litters from Hay Bay F1 York/Landrace sows in trial II) were randomly assigned into either a Heat (an additional 100W IR

heat lamp hovered behind a sow at farrowing, maintaining the farrowing zone temperature above 30°C) or a Non-Heat group. Within 12h after farrowing, the four smallest (minimum birth body weight of 0.6 kg) newborn piglets were selected from each litter and randomly assigned to one of the following four treatments: Control, C (6ml), CP-1 (7ml, 120mg/ml IgG) and CP-2 (8ml, 210mg/ml IgG) in trial I; Control, C (6ml), CP-3 (6ml, 60mg/ml IgG) and CP-4 (6ml, 120mg/ml IgG) in trial II. Results showed that the addition of heat at birth did not show any significant effect on piglet mortality at birth. There was not a significant effect on 3d or 7d piglet mortality associated with supplementation of energy or IgG to newborn pigs in this study. In addition, there was no difference for piglet weight gain from birth to 7d of life. Further investigations need to be conducted on the transfer and absorption of the supplemented IgG in neonatal pigs.

Key Words: Energy and Immunoglobulin Supplementation, Additional Heat, Piglet Mortality

T60 Effects of stocking rate and feeder space on pig performance in a wean-to-finish system. J. M. DeDecker*¹, M. Ellis¹, B. F. Wolter², and B. A. Peterson¹, ¹*University of Illinois, Urbana,* ²*The Maschhoffs, Inc., Carlyle, IL.*

The objective of this study was to determine the effects of feeder space and stocking rate during the first 8 wk post-weaning on pig performance from weaning (4.8 ± 0.03 kg BW; 15 ± 1d of age) to 23 wk post-weaning. Twenty pens of crossbred pigs (n = 960) were used in a randomized complete block design with a 2 × 2 factorial arrangement of treatments: 1) stocking rate (Single [32 pigs/pen] vs Double [64 pigs/pen]) and 2) feeder space (two spaces [81.3 cm/pen] vs three spaces [121.9 cm/pen]). The stocking rate treatment was imposed for 8 wk post-weaning, thereafter pigs on all treatments had the same group size of 32 pigs/pen. Floor spaces/pig during the treatment period were 0.66 m² and 0.33 m² for the single- and double-stocked treatments, respectively. There were no ($P > 0.05$) stocking rate by feeder space interactions. During the 8 wk double-stocking period, daily weight gain was higher ($P < 0.001$; 494 and 467 ± 4g/d) for the single-stocked pigs resulting in heavier ($P < 0.001$; 32.3 and 30.8 ± 0.23kg) BW at the end of wk 8. Providing three feeding spaces compared to two tended ($P = 0.08$) to improve daily weight gains (485 and 476 ± 4g/d) resulting in a trend ($P = 0.09$) for heavier BW (31.9 and 31.2 ± 0.23kg) at the end of wk 8. From the end of the double-stocking period to slaughter, there was a trend ($P = 0.06$) for average daily gain (839 and 862 ± 7g/d) to be higher for the double-compared to the single-stocked pigs resulting in similar ($P = 0.77$) BW at slaughter. There was no effect of feeder space during this period and BW were similar ($P = 0.71$) at slaughter. In summary, these results suggest double-stocking pigs for 8 wk post weaning reduces growth performance and BW at 8 wk, but that difference is not maintained to slaughter. Adding an additional feeder space did not significantly improve performance of double-stocked pigs in this study.

Key Words: Pigs, Stocking Rate, Feeder Space

Animal Health

T61 Dose-dependent cytokine expression in lipopolysaccharide activated bovine alveolar macrophages. J. A. Mills*, J. E. Campanicki, and R. M. Dyer, *Dept. of Animal and Food Sciences, University of Delaware, Newark.*

Pro- and anti-inflammatory cytokine gene expression in bovine alveolar macrophages could be reflected by level of lipopolysaccharide (LPS) challenge. Lavage procured alveolar macrophages (n=4) were exposed to 0, 1, 10, 100 and 1000 ng/ml of LPS (*E. coli*; O111:B4) for 6 hours. Levels of mRNA expression for IL-1 α , IL-1 β , TNF α , IL-10, IL-12, IL-18, TGF β and iNOS were determined by real time QPCR.

Expression of IL-1 α , IL-1 β and iNOS and peaked at 2.5, 11.3 and 13.0 fold higher ($P < 0.05$) than levels in unexposed cells, respectively at 100 ng/ml of LPS. TNF α expression changed within LPS stimulated alveolar macrophages, but differences between LPS treatments were only significant between 1 ng/ml and 100 ng/ml ($P < 0.05$), and tended to differ between 1 ng/ml and 1000 ng/ml ($P < 0.10$). In contrast, expression of IL-10, IL-12, IL-18 and TGF β decreased ($P < 0.05$) at all levels of LPS exposure with the greatest decrease appearing at 100 and 1000 ng/ml of LPS. These findings suggest the balance of inflammatory and anti-inflammatory cytokine expression is dependent upon levels of LPS

exposure and is strongly biased toward a pro-inflammatory response at higher doses of LPS exposure.

Key Words: Cytokines, Lipopolysaccharide, Alveolar Macrophages

T62 Cytokine and growth factor expression is regionally distributed in Holstein claws. J. A. Mills*, R. J. Grant, and R. M. Dyer, *Dept. of Animal and Food Sciences, University of Delaware, Newark.*

Horn tissue of healthy and diseased bovine claw is generated by keratinocyte replication and differentiation in the epidermal layer of the sensitive lamina. Since dermal-epidermal structures express cytokines and growth factors that regulate keratinocyte activity in other species we proposed bovine sensitive lamina expressed cytokine and growth factors. Accordingly, mRNA expression of IL-1 α , IL-1 β , IL-10, IL-12, IL-18, TNF α , TGF β , KGF, and GM-CSF was determined in sensitive lamina of normal coronary band, wall, sole and heel bulb using real time PCR. Expression of IL-1 α , IL-1 β , IL-10, IL-12, IL-18, TNF α , TGF β , KGF and GM-CSF was detected in the sensitive lamina and differed (P<0.05) between and within regions. Cytokine and growth factor expression was lowest overall in the heel bulb (P<0.05). Expression of IL-1 α and GM-CSF were similar across regions and levels of IL-10 were extremely low or not detected across all regions. Levels of IL-1 β expression were greatest (P<0.05) in the coronary band and wall, intermediate in the sole and lowest in the heel bulb. Expression of TNF α and KGF was highest (P<0.05) in the coronary band, intermediate in the wall and lowest in the bulb and sole. Levels of IL-12 and TGF β expression were greatest (P<0.05) in the coronary band and wall and lowest in the bulb. IL-18 expression was greatest (P<0.05) in the coronary band, intermediate in the sole and wall and lowest in the bulb. Thus the results indicated growth factors and many pro- and anti-inflammatory cytokines are expressed in normal bovine sensitive lamina. Their expression differed depending upon anatomic location of the sensitive lamina.

Key Words: Cytokines, Growth Factors, Sensitive Lamina

T63 Extracellular pH alters the innate immune response by enhancing phagocytosis and decreasing reactive oxygen species production. D. C. Donovan*¹, A. J. Reber¹, R. Parks¹, L. O. Ely², and D. J. Hurley¹, ¹*College of Veterinary Medicine, University of Georgia, Athens,* ²*Department of Animal and Dairy Science, University of Georgia, Athens.*

Intensive feeding management of today's feedlot and dairy cattle often results in systemic acidosis and an increase in respiratory disease. Previous research in our laboratory demonstrated that a slight change in venous pH lead to altered adaptive immune responses in steers fed acidogenic diets. In the present study, in vitro experiments were conducted on the innate immune response by evaluating the effects of media pH on phagocytosis and radical production of neutrophils and monocytes. Sixty milliliters of blood was obtained by jugular venipuncture from late lactation multiparous Holstein cows housed at the Athens Dairy Research Center of UGA (331 +/- 81 DIM) with an average body condition score of (3.2 +/- 0.3) for use in ROS assays (n = 12) and (337 +/- 82 DIM) with an average body condition score of (3.22 +/- 0.36) for phagocytic activity of neutrophils and macrophages (n = 12). Phosphate Buffer Saline was supplemented with 0.5% Bovine Serum Albumin and 5 mM Glucose and adjusted to pH 6.0, 6.4, 6.8, 7.2, 7.6, & 8.0. Data were analyzed by mixed procedures of SAS 8.2 (2002) with pH as the main effects. After stimulation with phorbol myristate acetate (PMA) for 1 h incubation at 37 C, the production of reactive oxygen species (ROS) was evaluated using a response ratio (PMA stimulated cells/unstimulated cells). Statistical analysis indicates that pH (P < 0.01) greatly effects the production of ROS, and acidosis decreased (P = 0.031) the production of ROS relative to alkalotic conditions. Additionally, phagocytosis of bodipy labeled E. coli and S. aureus tended (P = 0.12) to be increased under acidotic pH compared to alkalotic pH. Preliminary finding suggest nitric oxide production, after stimulation with lipopolysaccharide, also appears to be decreased at acidic conditions. These results suggest that acidotic pH alters the innate immunity.

Key Words: Acidosis, Immunity, Phagocytosis

T64 Elevation of tumor necrosis factor- α and α_1 -acid glycoprotein in lambs with consolidation of lung tissue. J. A. Daniel*¹, T. H. Elsasser², and W. Epperson¹, ¹*South Dakota State University, Brookings,* ²*USDA-ARS Growth Biology Lab.*

Previous research in cattle and sheep has indicated that lung lesions result in decreased animal growth, but mechanisms by which lung lesions result in decreased growth have not been identified. The objective of this research was to identify possible changes in circulating mediators of inflammation associated with lung lesions. As part of a study to determine timing of the onset of lung lesion development, lambs were slaughtered at three time points after weaning (day 1 n=21, day 50 n=20, and day 71 n=21). Serum was harvested and stored at -80°C until analysis. Percentage consolidation of each lobe of the lung was estimated for each lamb. Lambs were classified as having normal (<5 % consolidation of any lobe), moderate lesions (5-50% consolidation of any lobe) or severe lesions (>50% consolidation of any lobe). Circulating concentrations of tumor necrosis factor- α (TNF) were determined by RIA and circulating concentrations of α_1 -acid glycoprotein (AGP) were determined by radial immunodiffusion. For statistical analysis, sheep with AGP levels below the minimum detectable concentration (50 μ g/ml) were assigned an AGP concentration of 50 μ g/ml; effect of lesion scores and level of severity on circulating concentrations of TNF and AGP were tested using one-way ANOVA. Lambs with lesions, moderate or severe, had elevated circulating concentrations of TNF and AGP relative to normal lambs (75.9 \pm 2.3 vs. 68.7 \pm 2.2 pg TNF /ml and 183.6 \pm 44.6 vs. 76.0 \pm 21.3 μ g AGP /ml respectively, P < 0.05). Circulating concentrations of TNF and AGP did not differ between lambs with moderate or severe lesions (76.4 \pm 3.14 vs. 75.3 \pm 3.52 pg TNF /ml and 139.3 \pm 74.2 vs 232.3 \pm 45.3 μ g AGP /ml respectively, P > 0.05). These data indicate that circulating concentrations of TNF and AGP are elevated in lambs with lung lesions. Elevations in circulating concentrations of TNF and AGP in lambs with lung lesions are consistent with an inflammatory state that compromises health and growth.

Key Words: Lambs, Tumor Necrosis Factor-Alpha, Alpha₁-Acid Glycoprotein

T65 Failure to down regulate tumor necrosis factor- α (TNF- α) responses to repeated endotoxin (LPS) challenge in subpopulations of cattle constitutes a pathophysiologically relevant marker of risk for increased morbidity to disease. T.H. Elsasser* and S. Kahl, *USDA, Agricultural Research Service, Beltsville, MD.*

The tolerance phenomenon is a progressive physiological downregulation of the cytokine cascade responses to repeated challenge with inflammatory stimuli like LPS. Tolerance is considered necessary to attenuate the development of multiorgan failure that occurs from the formation of oxy-nitrogen free radicals and initiation of the complement C9 membrane attack complex (MAC) pathway. Using repeated, graded doses of *E. coli* 055:B5 LPS, we have identified and characterized subpopulations of cattle who fail to develop tolerance in their presentation of significantly greater changes in the immune response event-initiating proinflammatory cytokine TNF- α and corresponding indicators of increased morbidity and disease response. Crossbred beef heifers (n = 32, avg BW 323 kg) were injected twice in five days with LPS (0.8 μ g/kg BW^{0.75}) with representative blood samples obtained for measurement of plasma TNF- α by RIA. The TNF- α response index (T_{IND}, area response to the first challenge divided by the area response to the second challenge) for each heifer was ranked (Z-score) and outliers identified and grouped (tolerance failure heifers, TFH, n = 6) and retested with a contemporary group of tolerant heifers (TH, n = 6) at 9.46 μ g LPS/kg BW^{0.75}. T_{IND} responses to LPS were highly repeatable across dose and correlated (P<0.02). Replenishment of lost BW following LPS was delayed (P<0.02) in TFH vs TH. Plasma acute phase proteins (APP: serum amyloid-A and haptoglobin) concentration changes were greater and temporally prolonged (P<0.01) after the repeated LPS challenge in TFH vs TH. Immunohistochemical quantification indicated an increased number of cells and greater intensity of staining positive for MAC at 24 h post LPS in TFH vs TH (P<0.05). The data indicate that TNF- α and APP responses to repeated LPS challenge testing can identify animals at risk of greater morbidity response to disease vector challenge.

Key Words: Endotoxin, Immune tolerance, Regulation

T66 Exogenous testosterone (T) modulates tumor necrosis factor- α (TNF- α) and acute phase proteins (APP) responses to repeated endotoxin (LPS) challenge in steers. S. Kahl* and T. H. Elsasser, *USDA, Agricultural Research Service, Beltsville, MD.*

Clinical responses to some disease agents differ between sexes and this dimorphism has been attributed to the immunomodulating effects of estrogens and androgens. Our objective was to determine in steers the effect of T treatment on circulating concentrations of immune response mediators after two consecutive LPS challenges (LPS1 and LPS2, 5 d apart; 0.25 $\mu\text{g}/\text{kg}$ BW, i.v., *E. coli* 055:B5). Crossbred steers (n=16; 328 \pm 6 kg), fed a forage-concentrate diet (15% CP) to appetite, were assigned to control (C) or T treatment (n=8). Testosterone cypionate (100 mg/m² body surface, i.m.) was injected 12 and 2 d before LPS1. Mean plasma concentrations of T before LPS were 0.02 \pm 0.01 and 3.9 \pm 0.17 ng/ml in C and T, respectively. For each challenge, jugular blood samples were obtained at 0, 1, 2, 4, 7, and 24 h relative to LPS injection. The response to LPS challenge was calculated as area under the time \times concentration curve (AUC) for the parameter measured. After LPS1, TNF- α AUC was greater in T than C (3.17 vs 1.91 ng/ml \times h, P<0.05). Serum Amyloid-A (SAA) and plasma haptoglobin (HG) concentrations increased (P<0.01) after LPS1 and LPS2. In all steers SAA AUC was greater after LPS1 than LPS2 (P<0.01) but the response was augmented over C with T treatment (2.70 vs 2.05 mg/ml \times h, P<0.05). HG response to LPS1 within 24 h was not affected by T. However, 5 d after LPS1 mean plasma HG concentration remained higher in T than C (0.95 vs 0.27 mg/ml, P<0.01). HG response to LPS2 was greater in T than C (17.7 vs 9.7 mg/ml \times h, P<0.01). Results indicate that the presence of circulating T increases the magnitude of the TNF- α response to LPS challenge as well as the subsequent increases in APP. Effects of T on increases in TNF- α and APP may underlie a differential presentation of disease symptoms. The data also suggest a role for T in the development of tolerance to repeated immune challenge through its effect on the increased magnitude and duration of HG response.

Key Words: Acute Phase Proteins, Endotoxin, Testosterone

T67 Concomitant dual wavelength fluorescence evaluation of inducible nitric oxide synthase (iNOS) and cytokine responses to endotoxin (LPS) stimulation of bovine peripheral blood mononuclear cells (PBMC). C. Li*, D. Carbough, S. Kahl, and T. Elsasser, *Animal and Natural Resources Institute, Beltsville, MD.*

Cytokines exert autocrine and paracrine effects on the tissue response to immune challenge. Characterization of induced cytokine proteins and intracellular response mediators like nitric oxide (NO) can be used to characterize specific aspects of host responsiveness or resistance to disease challenge. LPS induces rapid formation of proinflammatory cytokines like tumor necrosis factor-alpha (TNF) and many TNF actions are mediated by NO generated from arginine through protein kinase b/AKT- mediated TNF upregulation of the iNOS gene promoter. Once formed, the 17 kD form of TNF is rapidly released from cells making it difficult to evaluate the cellular level of cytokine produced as well correlate its production to that of iNOS. In the present work, we optimized an immune challenge protocol, to rapidly evaluate TNF and iNOS responses in individual beef cattle. LPS (*E. coli*,055:B5) was added to whole blood (jugular, heparinized) to a final concentration of 2.0 $\mu\text{g}/\text{ml}$. Brefeldin-A, an antibiotic that blocks vesicular protein transport out of cells (Golgi-Block (tm), BD Scientific) was added at 1.0 $\mu\text{l}/\text{ml}$ blood. After discrete time periods, subsamples of the whole blood were permeabilized to permit passage of antibodies into cells; blood was incubated with anti-bovine TNF or anti-mouse iNOS. Red blood cells were eliminated by hypotonic lysis. PBMC TNF and iNOS responses were quantified by specific immunofluorescent staining using a dual wavelength fluorescence flow cytometer (Beckman-Coulter Cytomics Fc 500). Our data indicate that upon activation, the intracellular levels of TNF accumulate in the cells treated with brefeldin-A and iNOS increases significantly with a differential time course to that of TNF. The levels of TNF and i-NOS are correlated in PBMCs (P<0.01). By rapidly evaluating the functional interactions between iNOS and cytokines using whole blood in vitro challenge, we can develop strategies to more closely monitor animal health status.

Key Words: Endotoxin, iNOS, Cytokines

T68 The effects of anti-inflammatory agents on expression of cyclooxygenase-2 by bovine neutrophils. N. Cunningham*, P. Matterson, and M. Worku, *North Carolina Agricultural and Technical State University, Greensboro.*

Neutrophils (PMN) play a very important role in the inflammatory response of mammals. Cyclooxygenase-2 (COX-2) is one of two isoforms of the enzyme that catalyzes the production of prostaglandins. Bovine PMN release the COX-2 enzyme when stimulated with *Escherichia coli* lipopolysaccharide (LPS). Nonspecific steroidal anti-inflammatory drugs (NSAIDs) have been very effective at inhibiting COX-2 gene expression in man. The objectives of the present study were to evaluate the effect of commonly used NSAIDs on COX-2 gene expression in resting and stimulated bovine PMN. Blood collected from the jugular vein of four lactating Holstein cows was used to isolate PMN by differential centrifugation and hypotonic lysis of red blood cells. Viability was determined by Trypan blue dye exclusion, purity by differential cell counts and cell concentrations by using a hemacytometer. Subsequently, untreated or LPS stimulated PMN (5 \times 10⁶ cells/ml) were incubated for 30 minutes in the presence of either naproxen sodium, flunixin meglumine, acetaminophen, Ibuprofen, sodium salicylate, nordihydroguaiaretic acid, Indomethacin, Dexamethasone, or NS-398. Each NSAID was diluted to a final concentration of 1.0 μM / treatment. Cells were harvested, lysed and fractionated using SDS-PAGE. Cyclooxygenase-2 was positively identified on LPS treated samples using a specific antibody for western blot analysis. A band of 72 Kd was detected by enhanced chemiluminescence. All NSAIDs tested inhibited the expression of COX-2 on LPS stimulated bovine PMN. The tested reagents may be useful in targeting COX-2 gene expression for modulation of inflammatory diseases such as Mastitis.

Key Words: Neutrophil, Cyclooxygenase-2, NSAID

T69 Extracts of shitake mushrooms modulate receptors for immunoglobulins on bovine neutrophils. K. Gye-nai*, M. Worku, O. Ishekhumen, and P. Matterson, *North Carolina Agricultural and Technical State University, Greensboro.*

Phagocytic destruction of opsonized bacteria by bovine neutrophils (PMN) is mediated by receptors (FcR) binding IgM and IgG₂. Receptor-specific induction of genes ultimately determines cell fate. Binding of ligand to FcR results in signal transduction through the action of mediators. Expression of FcR by PMN is a marker of apoptosis. The aqueous extract of the Shitake mushroom (*Lentinus edodes*) decreases production of inflammatory mediators and apoptosis in human PMN. Two different extracts were evaluated for their effect on the modulation of immunoglobulin binding to and FcR expression on bovine PMN. Blood PMN from a Holstein cow were isolated by differential centrifugation and hypotonic lysis of red blood cells. Extracts of 20 grams of Shitake were prepared in phosphate buffered saline (PBS) and incubated at room temperature (RT) or at 90 °C for six hours. Isolated, viable PMN were treated with 100 μl of extracts in the presence of *E. coli* lipopolysaccharide (LPS) or PBS. Cells were then incubated with FITC labeled bovine IgG₂ or IgM for flow cytometric analysis of 10,000 cells in duplicate. The mean is presented. The percentage of untreated PMN binding IgM was 76%. Treatment with LPS or RT extract slightly decreased IgM binding 69% and 68% respectively. Treatment with the 90 °C extract decreased binding (44%). Expression of FcR for IgM in untreated PMN was 112. Treatment with LPS increased receptor expression to 180 and to 107 with the RT extract. The 90 °C extract decreased expression of FcR for IgM to 93. The percentage of untreated PMN binding IgG₂ was 44%. Treatment with LPS or mushroom extract prepared at 90 °C had no effect on IgG₂ binding (47% and 45% respectively). The RT extract increased binding (54%). Expression of FcR for IgG₂ in untreated PMN was 88. Treatment with LPS and the 90° C extract did not change receptor expression (72). The RT extract up-regulated expression of FcR for IgG₂ to 165. Extracts of Shitake mushroom differentially modulated binding and expression of receptors for IgM and IgG₂ on bovine PMN. Methods of extraction may determine the effect of mushroom derived compounds for therapeutic use in animal health. Further studies are warranted.

Key Words: Neutrophil, Fc Receptor, Mushroom

T70 Expression of 5'-lipoxygenase on bovine blood neutrophils. T. Harris*¹, M. Worku¹, P. Matterson¹, and D. Fargo², ¹North Carolina Agricultural and Technical State University, ²University of North Carolina at Chapel Hill, Chapel Hill.

Exposure to bacterial products such as endotoxin (LPS) results in activation of neutrophils (PMN) and associated inflammation. Studies have shown that following exposure to LPS components of somatic cells express genes for 5'-lipoxygenase (5'-LOX) a key enzyme in the synthesis of leukotrienes. Bovine PMN contribute to the Somatic cell count in milk in response to LPS exposure. The objectives of this study were to determine if bovine PMN express the gene for 5'-LOX and to assess the effect of exposure to LPS. Blood collected from the jugular vein of two lactating Holstein cows was used to isolate PMN by differential centrifugation and hypotonic lysis of red blood cells. Viability was determined by Trypan blue dye exclusion, purity by differential cell counts and cell concentrations by using a hemacytometer. Cells were exposed to *E. coli* LPS (10ng LPS for 30 minutes at 37°C or unexposed. RNA from unexposed and LPS exposed PMN was isolated using TRI-Reagent (Sigma). Specific forward and reverse primers for 5'-LOX were used. RNA was reverse transcribed to cDNA and amplified, observed on a 2% agarose gel and documented. The PCR product was sequenced commercially and Genbank and the Basic Local Alignment System (BLAST) were used to determine homology. The PCR product appeared as a band of 332 base pairs. Two sequences of length 320 and 349 were isolated and consequently showed homology with sequences from *Bos Taurus* partial mRNA, *Mus musculus*, and *Homo sapiens*. The PCR results and sequence information confirm that bovine PMN express 5'-LOX. The results indicate that the gene is expressed in LPS exposed and unexposed cells. Quantitative studies will be conducted to assess the levels of gene expression following LPS exposure. Bovine PMN may contribute to the production of leukotrienes in inflammatory diseases such as mastitis through 5'-LOX gene expression. The gene for 5'-LOX is an ideal target for the design of therapeutics based on 5'-LOX inhibition to block leukotriene synthesis.

Key Words: 5'-lipoxygenase, Neutrophil, Sequence

T71 Ergovaline transport across human gastrointestinal cells (Caco-2). N. W. Shappell* and D. J. Smith, *USDA-ARS Biosciences Research Laboratory, Fargo, ND.*

The gastrointestinal (GI) cell model Caco-2 (derived from human colon carcinoma) was used to assess ergovaline transport. Cells were grown in transwell inserts until monolayers were established (~day 20 in culture). A pre-equilibrated mixture of ergovaline/ergovalinine (60:40; 10 and 40 μ M concentrations) was added to the apical wells (equivalent to mucosal side) in media containing phenol red. Basal media (equivalent to serosal side) contained no phenol red or ergovaline/inine. Diffusion of compounds through filters with no cells present was also measured. Apical and basal media were extracted, and isomer concentrations were determined by HPLC with fluorescence detection. Monolayer integrity was maintained throughout the 12h experimental period, as assessed by the absence of phenol red in basal media. Kinetics of isomers were identical. In the absence of cells, basal accumulation of isomers was essentially linear for three h at 10 and 40 μ M concentrations, after which basal accumulation plateaued (regression curves best described by ln equation; R^2 from 0.85 to 0.96). A second order polynomial equation best described the regression analyses of basal isomer accumulation in the presence cells (R^2 from 0.94 to 1.00). The linear phase of accumulation extended to 240 min with cells. Little change in basal accumulation was observed from 6 to 12 h. After six h in the presence of cells, ~25% and 40% of dose had accumulated in the basal compartment for 10 and 40 μ M ergovaline, respectively. These experiments show that both ergovaline and its naturally occurring isomer, ergovalinine, readily cross GI mucosal cells intact and with similar kinetics. Because both isomers were transported, either isomer, or a combination of both, could be involved in the pathogenesis of fescue toxicosis at sites distal to the G.I.

Key Words: Ergovaline, Fescue Toxicosis, Caco-2

T72 Assessment of TascoTM and YCWP on ergovaline toxicity in Caco-2 cells. N. W. Shappell* and L. O. Billey, *USDA-ARS Biosciences Research Laboratory, Fargo, ND.*

The seaweed extract TascoTM and yeast cell wall preparation (YCWP) were tested to evaluate efficacy in attenuation of ergovaline toxicity to Caco-2 cells. Initially cells were treated with 0.1% to 0.001% Tasco, to identify potential TascoTM toxicity. By ~24h at 37 °C in the presence of media (with or without cells) globules formed. After consultation with manufacturers, it was concluded that calcium and magnesium concentrations present in the medium were causing coalescence of the alginates present in TascoTM resulting in globules. TascoTM was toxic at high concentrations (72h, 0.001% to 0.1% yielded ~66% to 1% of control values, respectively, as assessed by metabolic activity (using the alamarBlueTM assay) and total protein. Ergovalines toxicity (100 μ M) was tested +/- TascoTM (0.0001% and 0.00005%, 72 h) on undifferentiated cells. At these concentrations, TascoTM was non-toxic and it did not alter the toxicity of ergovaline (~40% reduction of metabolic activity and/or total protein relative to control cells with ergovaline treatment). As YCWP is not water soluble, DMSO extraction was used (0.1g/ml). The cellular effect of YCWP in DMSO (ranging from 0.1-0.5%) was evaluated on cells. DMSO alone was found to reduce metabolic activity and total protein at concentrations greater than 0.2%. Therefore YCWP was tested in 0.05% and 0.1% DMSO. At the 0.05% DMSO/YCWP there was a slight amelioration of the toxicity caused by ergovaline (10-20%). At the 0.1% concentration, no amelioration was seen and ergovaline toxicity may have been increased slightly (<10%). Further investigation of TascoTM and YCWP at different concentrations may be warranted. An unexpected finding was the reduction of ergovaline toxicity when cells were treated in the presence of DMSO.

Key Words: Ergovaline, Yeast Cell Wall Prep, Tasco

T73 Effects of an oral rehydration solution with added bovine serum proteins on small intestinal absorptive capacity. S. I. Kehoe*¹, J. D. Quigley, III², and H. D. Tyler¹, ¹Iowa State University, Ames, ²American Protein Corporation, Ames, IA.

Calves commonly become infected with viruses and bacteria that damage the intestinal lining. Although calves cannot absorb IgG after 48 h of age, oral IgG may bind to intestinal lining. This IgG binding may decrease the levels of pathogens in the gut. To enhance recovery of small intestinal function following a coronavirus challenge, bovine serum proteins, containing IgG, TGF- β and other growth factors, were added to an oral rehydration solution (ORS) for 16 Holstein and Jersey calves. Calves were housed individually and offered water ad libitum and milk replacer at 10% of BW. Treatments consisted of a control ORS (CON) and ORS with added bovine serum proteins (GFR). After a 2 d adjustment, calves were orally challenged with bovine coronavirus. Xylose (0.5 g/kg) was administered orally once daily for 6 d and jugular blood was sampled at 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4 h post-dosing. Hematocrits, fecal dry matter, rectal temperatures, attitude scores and dehydration scores were recorded once daily. Concentrations of serum xylose were numerically higher on d 6 (27.1 ± 4.9 mg/dl for CON and 24.9 ± 5.3 mg/dl for GFR) than d 3 (13.7 ± 4.6 mg/dl for CON and 17.0 ± 4.7 mg/dl for GFR) but treatments did not differ significantly. Hematocrits and other scores were not significantly different between treatments. In this model, bovine serum proteins did not enhance intestinal recovery from a coronavirus challenge when added to ORS.

Key Words: Calves, Oral Rehydration Solution, Bovine Serum Proteins

T74 Effects of small intestinal absorption in calves treated with an oral rehydration solution supplemented with fat-soluble vitamins. S. I. Kehoe*¹, H. D. Tyler¹, M. L. O'Brien², K. J. Touchette², and J. A. Coalson², ¹Iowa State University, Ames, ²Merrick's, Inc., Middleton, WI.

Young calves commonly become infected with viruses and bacteria that damage the intestinal lining. Deficiencies in fat-soluble vitamins also occur in young calves and may impair the rate of differentiation of intestinal epithelial tissues, especially following enteric infections. To enhance recovery of small intestinal function following a coronavirus challenge, fat-soluble vitamins were added to an oral rehydration solution (ORS) for 16 Holstein and Jersey calves. Calves were housed individually and

offered water ad libitum and milk replacer at 10% of BW daily. Treatment one consisted of a control ORS (CON). Treatment two consisted of added antioxidants, to provide 70,000 IU of vitamin A and 300 IU of vitamin E per day (VIT). After a 2 d adjustment, calves were orally challenged with 5×10^6 plaque-forming units of a moderately virulent bovine coronavirus isolate. Xylose (0.5 g/kg of BW) was administered orally once daily for 6 d and jugular blood was sampled at 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4 h post-dosing. Hematocrits, fecal dry matter, rectal temperatures, attitude scores and dehydration scores were recorded once daily. Serum xylose concentrations were higher on d 6 (27.1 ± 4.9 mg/dl for CON and 20.2 ± 3.7 mg/dl for VIT) than on d 3 (13.7 ± 4.6 mg/dl for CON and 14.9 ± 4.2 mg/dl for VIT) but were not significantly different between treatments. Hematocrits and other clinical scores were not significantly different between treatments. In this model, antioxidant vitamins did not appear to enhance intestinal recovery from a coronavirus challenge when added to ORS.

Key Words: Calves, Oral Rehydration Solution, Fat-Soluble Vitamins

T75 Effectiveness of ground endophyte-infected tall fescue seed in production of fescue toxicosis in cattle. L. E. Wax*, D. E. Spiers, G. E. Rottinghaus, and T. J. Evans, *University of Missouri, Columbia.*

Cattle fed endophyte-infected tall fescue (E+) in the form of whole seed during heat stress experience increased hyperthermia, and reduction in both feed intake and weight gain. This study determined if intake of diet containing ground infected fescue seed would increase fescue toxicosis as a result of increased absorption of toxin. Steers (n=18; 300kg avg. BW) were housed in the Brody Climatology Laboratory and randomly assigned to daily diet treatments of either E+ (20-40 μ g ergovaline/kg BW) or control (endophyte-free, E-) seed. Animals were exposed to a 14 day heat challenge (HC) reaching 36°C during the day and 26°C at night and fed twice daily at 0800 and 1600 with water available *ad libitum*. Core temperature was measured continuously using telemetric, temperature transmitters (CowTemp, Model BV-010) with respiration rate, skin and rectal temperatures recorded four times daily. Ground E+ decreased feed intake below control by day 7 at thermoneutral (TN) (p<.0001). Maximum reduction in feed intake at TN was 25% from pre-treatment with an additional 46% decrease during HC. By the end of HC, E+ feed intake increased to E- levels, suggesting there is a recovery from the effect. In contrast to previous studies using whole seed, there is no evidence of change in core temperature from control levels. A preliminary study was done using fistulated steers to determine if this level (20 μ g ergovaline/kg BW) of seed is capable of producing an increase in core temperature above the E- level. Steers were fed E- seed for 3 days switched to E+ seed for 5 days followed by E- seed for 3 days, during HC. Peak rectal temperature rose 1.3°C from E- to E+ treatment periods. Therefore core temperature response and feed intake are independent of each other with feed intake being more sensitive. Ground fescue seed elicits a robust temperature response, once the large effect on feed intake is overcome.

Key Words: Cattle, Endophyte, Heat Challenge

T76 Effect of Eprinex® on subsequent 90-day production in Virginia Holstein herds. K. L. Rossini*¹, M. L. McGilliard¹, and R. H. Nutt², ¹Virginia Tech, Blacksburg, ²Valley Feed Co., Staunton, VA.

One trial involving four Holstein herds and 270 total dairy cows was conducted to determine if cows treated once with Eprinex® (Merial) produced more milk in subsequent months than did untreated cows. Cows were generally confined and averaged 33 kg/d of milk. Odd-numbered cows in each herd were treated with Eprinex® (1 ml/10 kg body weight) whereas even-numbered cows were left untreated. A single treatment was administered on or near one DHI test day in March, April or May. Test-day data were down-loaded for that initial test day and the next 3 monthly tests. Change in production from month zero was analyzed with a model containing effects of treatment, herd (random), month (repeated), parity (first and older), and initial days in milk (<90, 90-270, >270 d). Variables analyzed were test-day milk, percentages of fat and protein, and SCC score. A total of 211 cows remained for all four test days. Change in milk per cow from mo 0 to 1 was 2.7 kg/d (0.5 SE) greater for treated cows. The advantage was maintained at 2.7 kg/d (0.8 SE) to mo 2, and 3.1 kg/d (0.8 SE) to mo 3 (cumulative from mo 0). For cows in milk less than 90 d, treated cows had an advantage of

5.4 kg/d (1.1 SE) to mo 1, 6.6 kg/d (1.7 SE, NS) at mo 2, and 6.5 kg/d (1.7 SE) at mo 3. For cows in early lactation, 7 of 13 untreated cows increased in milk from mo 0 to 1, whereas 10 of 11 treated cows increased. Initial days in milk were 72 and 69 d for those untreated and treated groups. The advantage for cows more than 90 d in milk at treatment was not significant at less than 2 kg/d. Fat changed 0.33% more by the mo 2 for cows dosed in mid-lactation. Change in percentage protein and somatic cell score did not differ between treated and untreated cows. At a cost of \$4.00 per cow for product and labor, 0.35 kg of feed dry matter consumed for each kilogram of additional milk, \$0.15/kg of dry matter, and \$0.28/kg milk, the net value for 90 d of 3.1 kg/d would be \$0.66/d per cow (\$0.86 milk - \$0.04 product and labor - \$0.16 feed).

Key Words: Eprinex, Milk Yield, Eprinomectin

T77 Frequencies of calving-related diseases of Holstein dairy cows injected with low doses of bovine somatotropin during the transition period. M. Liboni*, M. J. Hayen, M. S. Gulay, T. I. Belloso, and H. H. Head, *Department of Animal Sciences, University of Florida, Gainesville.*

Objective was to evaluate effects of injecting bST (0.4 mL, 10.2 mg/d, POSILAC®) during the prepartum and/or early postpartum periods on incidence rate of calving-related disorders of dairy cows during the first 60 d postpartum. Multiparous Holstein cows (n=150) were assigned randomly to a 2x2 arrangement of treatments to give four groups (I=no bST, n=26; II=bST postpartum, n=25; III=bST prepartum, n=27; IV=bST prepartum and postpartum, n=25) plus a group of cohorts (V=cohort, n=47). Biweekly injections of bST were in left or right ischio-rectal fossa beginning 3 wk before expected calving through 70 DIM. Disease frequencies were collected from farm records, and incidence rates (number of diseased cows divided by the total number of cows) were reported for each group. Across all TRT groups (n=150) the observed incidence rates were: retained fetal membranes (RFM, 15%), metritis (MET, 36%), clinical mastitis (MAT, 22%), digestive problems (indigestion [DIG], 11%), ketosis (KET, 4%), milk fever (MF, 1.3%), displaced abomasum (DA, 3.3%) and lameness (LAME, 4.6%). Incidence rates of RFM, MET, MAT and DIG for TRT I, II, III, IV and V were 19.2, 16, 7.4, 0.0 and 25.5 %; 42.3, 32.0, 37.0, 32.0 and 42.5%; 30.7, 28.0, 14.8, 20.0 and 21.2%; and 19.2, 16, 11.1, 0.0 and 8.5 %, respectively. The proportions of sick cows in a group (number of cows that had one or more cases of disease divided by the total number of cows) were 76.9, 64.0, 59.2, 48.0 and 65.9 %, respectively. Significant Chi-Square values were detected between TRT I vs. TRT IV cows for RFM and DIG (P<0.028). In addition, there tended to be greater number of healthy cows on TRT IV than on TRT I (P<0.0649). No differences were detected between TRT I and cohorts. Results indicated that bST injected during the transition period did not increase the incidence of calving-related disorders. Furthermore, cows on TRT IV were less likely to have RFM, DIG and tended to be healthier than non-injected cows.

Key Words: bST, Transition Period, Diseases

T78 The effect of Johne's disease on culling and milk production in nine Ontario dairy herds. S. H. Hendrick*¹, T. F. Duffield¹, D. F. Kelton¹, K. E. Leslie¹, K. D. Lissimore¹, and M. Archambault², ¹Ontario Veterinary College, University of Guelph, Guelph, ON, Canada, ²Animal Health Laboratory, University of Guelph, Guelph, ON, Canada.

The objective of this study was to evaluate the influence of Johne's disease (JD) on culling and milk production on Ontario dairy herds. During the summer of 2002, 9 Holstein dairy herds with a previous history of JD were enrolled in this study. Blood and fecal samples were collected from all milking and dry cows (868 cows). Serum samples were submitted to the AHL, for a commercial ELISA. Fecal samples were sent to AntelBio Systems for traditional fecal culture. Milk samples were collected from all milking cows at the herds next DHI test day (690 cows). The milk samples were sent to AntelBio for an in-house milk ELISA. Test results were not returned to the producers until January 2003. Milk production and culling data were retrieved from the DHI database. 305-day milk production was compared to JD status as predicted by the three diagnostic tests. A separate model was made for each test with the effects of mastitis, DIM, parity and herd controlled in each of the models. Culling data was collected between the farm visit date and Dec. 31, 2002. Proportional hazards models were used to evaluate the days to culling stratified by JD status with separate model

for each test, and controlling for herd, DIM, parity, pregnancy status and linear score. Fecal culture positive cows produced 548 kg less milk than fecal culture negative cows. Similarly, milk ELISA positive cows had a decrease of 457 kg versus milk ELISA negative cows. There was no statistical difference in 305-day milk production in seropositive cows. Survival analysis showed that fecal culture positive cows were 3.16 times more likely to be culled than non-shedding cows. Milk ELISA positive cows were 2.27 times more likely to be culled than milk ELISA negative cows. There was a tendency for serum ELISA positive cows to be culled 1.72 times more than seronegative cows. For the 9 herds in this study, JD significantly limited milk production and cow longevity.

Key Words: Paratuberculosis, Culling, Milk Production

T79 *Escherichia coli* and *Staphylococcus aureus* elicit differential innate immune responses following intramammary infection. D. Bannerman¹, M. Paape¹, J.-W. Lee², X. Zhao², J. Hope³, and P. Rainard⁴, ¹Bovine Functional Genomics Laboratory, USDA-Agricultural Research Service, Beltsville, MD, ²Department of Animal Science, McGill University, Ste-Anne-de-Bellevue, QC, Canada, ³Institute for Animal Health, Berkshire, UK, ⁴Institut National de la Recherche Agronomique, Nouzilly, France.

Staphylococcus aureus and *Escherichia coli* are among the most prevalent species of Gram-positive and Gram-negative bacteria, respectively, that induce clinical mastitis. The innate immune system comprises the immediate host defense mechanisms to protect against infection and contributes to the initial detection of and pro-inflammatory response to infectious pathogens. The objective of the current study was to characterize the differential innate immune response to experimental intramammary infection with *E. coli* and *S. aureus*. The cytokine response and changes in the levels of soluble CD14 (sCD14) and lipopolysaccharide (LPS)-binding protein (LBP), two proteins that contribute to host recognition of bacterial cell wall products, were studied. Intramammary infection with either *E. coli* or *S. aureus* elicited systemic changes that were statistically significant including decreased milk output, a febrile response, and induction of the acute phase synthesis of LBP. Infection with either bacteria resulted in significantly increased milk levels of IL-1 β , IFN- γ , IL-12, sCD14, and LBP. Significantly higher levels of the complement cleavage product C5a, and the anti-inflammatory cytokine IL-10, were detected at several time points following *E. coli* infection, whereas, *S. aureus* infection elicited a slight but significant increase in these mediators at a single time point. Significant increases in IL-8 and TNF- α were only observed in quarters infected with *E. coli*. Together, these data demonstrate the variability of the host innate immune response to *E. coli* and *S. aureus* and suggest that the limited cytokine response to *S. aureus* may contribute to the well-know ability of this bacterium to establish chronic intramammary infection.

Key Words: Mastitis, Innate Immunity, Inflammation

T80 Ultrasonographic characteristics of the uterus of Holstein cows with late endometritis. J. K. Haskell¹, D. S. Hammon², and G. R. Holyoak³, ¹Department of Forest, Range and Wildlife, Utah State University, Logan, ²Department of Animal, Dairy and Veterinary Sciences, Utah State University, Logan, ³Department of Clinical Sciences, College of Veterinary Medicine, Oklahoma State University, Stillwater.

Endometritis in dairy cows is common during the prebreeding period and has a profound negative impact on reproductive efficiency. Further characterization of endometritis and easily utilized, non invasive, and accurate methods to diagnose endometritis are needed. The objective of this study was to determine the potential for using ultrasonography as a method for diagnosing subclinical endometritis in early lactational dairy cows. To assess subclinical endometritis, primiparous and multiparous Holstein dairy cows were examined 40 to 60 days postpartum. The reproductive tract of each cow was examined using transrectal ultrasonography, and measurements of uterine horn diameter, and endometrium height were obtained by electronic caliper. Frozen ultrasound images of uterine horn transverse sections were recorded for later evaluation to determine the presence of endometritis, based on echoid particles and fluid within the uterine horn lumen. Uterine cytology was performed as a definitive diagnosis of endometritis for each cow. Specificity and sensitivity of ultrasound were established based upon the results of two investigators and compared to uterine cytology. Specificity was 97%

and 64%; and sensitivity was 53% and 57% for evaluator 1 and 2, respectively. Measures of uterine endometrium height difference between horns, and maximum endometrium height were significantly associated with the presence of endometritis. This finding supports the use of ultrasound to accurately detect endometrial changes, which are associated with endometritis.

Key Words: Subclinical Endometritis, Uterine Cytology, Ultrasonography

T81 Antimicrobial Susceptibility Of Coagulase-Negative Staphylococci Isolated From Hands Of Urban Children, Farm Workers, and Dairy Cow Teat Skin. M. M. Pol^{*}, C. C. M. Hulland, and P. P. L. Ruegg, University of Wisconsin, Madison.

There is increasing concern that antimicrobial use in animals can create a reservoir of resistant bacteria that could be transferred to humans. The aim of this study was to compare results of antimicrobial susceptibility tests of coagulase-negative staphylococci (CNS) isolated from teat skin of cows, and hands of children and farm workers. Swabs (Quick Swab, 3M) were obtained from hands of farm workers (n = 39), urban children (n = 36), and from teat skin of dairy cows (n = 32). Swabs were cultured on blood agar plates and incubated at 37 C. CNS were speciated using a commercial microbial identification system. MIC values were obtained using a commercial microdilution system (Sensititre, Westlake, OH). Isolates classified as intermediate were reclassified as resistant for statistical analysis. MIC values were obtained for CNS isolated from children (n = 57), farm workers (n = 64), and teat skin (n = 42). There were no significant differences in MICs of CNS isolated from farm workers among farms. MICs of CNS obtained from teat skin varied among farms for erythromycin and sulfadimethoxine (P #8804 0.05). For most antimicrobials, there were no significant differences in MIC based on source of the isolate. MICs for erythromycin and sulfadimethoxine were significantly higher for farm workers as compared to urban children (P #8804 0.05). MICs for tetracycline were significantly higher for CNS obtained from farm workers as compared to CNS obtained from children and teat skin (P < 0.001). Source of isolate was significantly associated with resistance for ampicillin (P = 0.04), penicillin (P = 0.02), erythromycin (P = 0.03), pirlimycin (P < 0.001), sulfadimethoxine (P = 0.04), and tetracycline (P < 0.001). The probability of resistance was 0.3, 0.4, 0.1 and 0.2 for children as compared to farm workers for ampicillin, erythromycin, pirlimycin and tetracycline respectively. The probability of resistance was 0.3, 0.2 and 0.04 for children as compared to teat skin for erythromycin, penicillin, and pirlimycin, respectively.

Key Words: Antimicrobial Susceptibility, Coagulase-Negative Staphylococci

T82 Heel erosion in dairy cattle. L. G. Baird¹, L. C. Pinheiro Machado Filho², M. A. G. von Keyserlingk¹, D. M. Weary¹, and K. A. Beauchemin³, ¹Animal Welfare Program, University of British Columbia, Vancouver, BC, Canada, ²Universidade Federal de Santa Catarina, Brazil, ³Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.

Heel erosion, one of the most common hoof disorders in dairy cattle, begins as shallow irregular grooves in the heel horn and can progress to deep oblique grooves resulting in major loss of heel structure. Although some research is available for European farms, to date no published studies have addressed this disorder for North American dairy herds. The objective of this study was to monitor the progression of heel erosion in a cohort of Holstein cows, examining the effects of parity and stage of lactation. The hind hooves of 20 heifers and 38 multiparous cows were scored at least once pre-calving, in early lactation (0-100 DIM) and in mid-lactation (100-200 DIM). Specifically, we noted any grooving on the four hind claws (medial and lateral, left and right), and if these grooves were irregular or oblique. Any claw with oblique grooves or major loss of heel structure was classified as having severe erosion. During pre-calving observations, the average number of claws per cow with severe heel erosion was 0.59 \pm 0.12, but by mid-lactation this score had increased to 2.7 \pm 0.20 (P < 0.001). Erosion was also related to parity, with the older cows experiencing higher scores (P < 0.001), especially in early and mid-lactation (P < 0.02 for period by parity interaction). The

results of this study indicate that heel erosion is a common affliction, especially for mid-lactation multiparous cows.

Key Words: Heel Erosion, Dairy Cattle, Hoof

PSA - Pathology

T83 Identification of a c-reactive protein gene in cardiomyopathic turkeys: A possible genetic marker for turkey cardiomyopathy. A. E. Hauser* and M. M. Corley, *Tuskegee University, Tuskegee, AL.*

C-reactive protein (CRP) is an inflammatory protein released by the body in response to infection and injury. Elevation of this serum protein has been linked to increased risks of heart disease through inflammation that is believed to play a key role in the hardening of arteries resulting in a heart attack or stroke. Consequently, CRP could serve as a genetic marker for an eminent cardiac event. Thus far, the poultry industry has experienced considerable loss due to turkey cardiomyopathy. Furthermore, the gross and microscopic lesions in tissue from cardiomyopathic turkeys, have been shown to be very similar to human cardiomyopathic heart tissue. Therefore investigation of those genes involved in turkey cardiomyopathy can lead to further insight of cardiovascular disease and thus benefit both the poultry industry and the human population. In this study, we attempted to identify a crp gene from turkeys that carry a genetic trait (unknown) that renders them susceptible to cardiomyopathy. The identification and expression of this gene as it relates to heart disease in these turkeys has not been investigated. The reverse transcriptase polymerase chain reaction (RT-PCR) was used to target this gene. Total RNA, extracted from frozen heart tissue (0.1g) of a cardiomyopathic turkey was used to generate turkey cDNA, and oligonucleotide primers were designed from a partial crp gene sequence derived from a chicken liver cDNA library to amplify the crp gene. The expected 504 bp RT-PCR product was successfully amplified. Identification and analysis of the gene that codes for CRP in turkeys will lend further insight into the etiology of turkey cardiomyopathy.

Key Words: Cardiomyopathic, C-reactive Protein, Turkeys

T84 Identification and analysis of an apolipoprotein- A gene in cardiomyopathic turkeys. T. A. Dugger* and M. M. Corley, *Tuskegee University, Tuskegee, AL.*

Apolipoprotein A is a major constituent of high-density lipoproteins, which aids in the regulation of high cholesterol levels in the blood and peripheral tissues. If this process is defective, cholesterol molecules can accumulate in arteries, result in arterial blockage, thereby leading to a cardiac event (heart attack). The turkey cardiomyopathic heart resembles that of humans in gross and microscopic morphology. Therefore analysis of genes implicated in turkey cardiovascular disease may be beneficial to both poultry and human health. Heart tissue from cardiomyopathic turkeys was used to identify an apoA gene and its possible involvement in cardiovascular disease. The role of this gene as it relates to turkey cardiomyopathy has not been investigated. To isolate this gene, total RNA was isolated from heart tissue samples and purified. Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) was performed using primers designed from the chicken apoA-1 gene. The RT-PCR product was visualized via agarose gel electrophoresis (1.5% w/0.5 µg/ml ethidium bromide). The expected 519 bp RT-PCR product was observed, indicating successful amplification of the apoA gene from cardiomyopathic turkey heart tissue. Identification and analysis of the turkey apoA gene will lead to further knowledge of the etiology of turkey cardiomyopathy.

Key Words: Apolipoprotein, Cardiomyopathy, Turkeys

T85 Isolation and characterization of an anti-Salmonella phage collection for use as antibacterial agents. E. Kozhina*, P. Herrera, and S. Ricke, *Texas A&M University, College Station.*

Interest in phage therapy has increased in the past several years due to the rise in the antibiotic resistance. There are several problems to overcome before bacteriophages can be routinely used as antibacterial agents. One problem is that most bacteriophages are highly specific

infecting only a few host strains of bacteria. However some bacteriophages exhibit a wider host range. Another problem is the maintenance of the stability and viability of a phage collection. Our objective is to isolate a stable phage collection capable of lysing a number of different *Salmonella* strains. First, we isolated phages from the environmental water samples. This was followed by five consecutive step propagation procedures in a mixture of *Salmonella* strains and in four different *Salmonella* strains. A number of plaques grew on a bacterial lawn containing the 4 *Salmonella* strains. The largest and clearest plaques were chosen for further study. We investigated stabilizer (YT media supplemented with 10 mM MgSO₄, 1% BSA and 5% sucrose) for storage of phage collection. We found that it result in 100% recovery of newly isolated phage collection stored for a month in 4°C (compare to 98% of recovery in SM buffer (100 mM NaCl, 8 mM MgSO₄, 50 mM Tris-Cl, pH 7.5). The DNA from these phages were isolated, digested with EcoRI restriction enzyme, and the banding patterns analyzed by agarose electrophoresis. In order to select for the most stable phage isolates, the mixtures of primary phage isolates were stored for 5 months at 4°C. Phages isolated from these mixtures were tested for their ability to survive while incubated in non-sterile bovine rumen fluid at 37°C. Stabilizers, such as 1M MgSO₄ and 1% gelatin, were added to determine if they could enhance the bacteriophages survival. In all cases phages were isolated from rumen fluid after 3 days of incubation. The presence of stabilizer did not influence phage stability in rumen fluid. Initial results indicate that these procedures, with minor modification, can be used routinely to generate a useful and stable anti-*Salmonella* phage collection.

Key Words: *Salmonella*, Phage, Isolation

T86 Pathology of listeriosis resulting from respiratory infection of turkey poults with *Listeria monocytogenes* Scott A. G. R. Huff*¹, W. E. Huff*¹, J. N. Beasley², M. G. Johnson², R. Nannapaneni², J. M. Balog¹, and N. C. Rath¹, ¹USDA/ARS/PPPSRU, ²University of Arkansas.

The pathogenesis of a human epidemic strain of *Listeria monocytogenes*, Scott A, was studied by challenging day-old turkey poults with air sac inoculation of 10⁰ (Control), 10⁴, 10⁵, 10⁶, 10⁷, or 10⁸ cfu. Respiratory challenge with all levels resulted in listeriosis. Mortality at 2 wk post-infection ranged from 25-100% and was directly correlated with level of challenge. Gross pathology included enlarged gall bladders and pale livers, some of which were also yellowish, mottled, or cooked in appearance. Ruptured yolk sacs were common. Lungs were necrotic and hearts were swollen and surrounded by fluid. Sections of liver, heart, spleen, bursa, lung, and brain were fixed in 10% buffered formalin. Paraffin-embedded sections were cut at 5µ, stained with hematoxylin and eosin as well as Gram stain and were examined for histological lesions. Lesions were observed in liver, heart, spleen, bursae, and lung, however no significant changes were present in brain. The myocardial lesions consisted of large infiltrations of mononuclear cells deep in the myocardium and were associated with Gram positive rods. In the liver, focal infiltrations of mononuclear cells were small and scattered and were also associated with Gram positive rods. Congestion and reticuloendothelial hyperplasia were prominent in the spleen and there was necrosis of scattered cells. Lymphocytes and mononuclear cells infiltrated areas surrounding bronchi in the lung. In the bursae there was depletion of lymphocytes in bursal follicles. *Listeria* challenge also resulted in significantly decreased relative weight of the bursa of Fabricius and increased relative weight of the spleen. *L. monocytogenes* was isolated by direct plating of liver, gall bladder, pericardium, brain, yolk sac, lung, cecal tonsil, and both left and right knee synovium cultures on UVM *Listeria* selective agar. These results suggest that respiratory infection with *L. monocytogenes* can be invasive in young turkeys and may be responsible for some unexplained cases of early poult mortality as well as the initiation of chronic infection leading to product contamination.

Key Words: *Listeria Monocytogenes*, Respiratory Infection, Turkeys

T87 Aspirin and selenium influence on bordetellosis in turkey poults. A. M. Tyner*, F. W. Edens, and G. H. Luginbuhl, *College of Agriculture & Life Sciences, Dept. of Poultry Science, North Carolina State University, Raleigh.*

Bordetellosis, caused by *Bordetella avium* infection, is characterized by tracheal inflammation, epithelial cell degeneration, and tracheal distortion. The inflammation results from dermonecrotic toxins produced by *B. avium*. Inflammatory reactions are accompanied by generation of reactive oxygen metabolites (ROM) that kill cells. Antioxidant enzyme activity associated with either sodium selenite (SS) or organic selenium (SP, Sel-Plex, Alltech, Inc., Nicholasville, KY) elevates cellular redox status to reduce ROM. Aspirin (AS) can be an antioxidant because it inhibits synthesis of oxidative prostacyclins that induce ROM. The objective of this work was to examine the influence of AS with either SS or SP on development of bordetellosis in female poults. Experiments were conducted with day of hatch poults given intranasally 107 cfu of W strain *B. avium* or no challenge and monitored for 21d post challenge. Challenged and non-challenged poults were given 6 experimental diets made with poult starter- 1. SS (0.3 ppm), 2. SP (0.3 ppm), 3. no selenium or AS, 4. SS (0.3 ppm)+AS (.05%) 5. SP (0.3 ppm)+AS (0.05%), 6. AS (0.05%). At 9 and 14d, 5 poults (1/rep of 7 poults/rep) were killed and necropsied. Regardless of dietary treatment, lower BW ($P<0.05$) was observed in infected groups. In one experiment, AS prevented epithelial cell degeneration in infected poults. In control groups, SP alone and SP+AS increased thymus weight (g/100 g BW) over other treatments ($P<0.06$). With infection, SP only was associated with a smaller thymus, but addition of AS maintained thymus wt equal to the other treatments. Bursa and spleen wt were not altered significantly by selenium source, AS, or infection. Abdominal exudate macrophage IL-1 was elevated significantly ($P<0.0001$) by SS but not by SP or AS, and infection elevated IL-1 ($P<0.001$). It was concluded that SP and AS can alter the course of developing bordetellosis

Key Words: Selenium, Aspirin, Bordetellosis

T88 Silymarin PHYTOSOME against AFB₁ in broilers: effects on serum biochemistry. D. Tedesco¹, S. Galletti¹, L. Ravarotto², M. Tameni¹, S. Steidler¹, and P. Morazzoni³, ¹Department of Veterinary Sciences and Technologies for Food Safety, Milan, Italy, ²Istituto Zooprofilattico Sperimentale delle Venezie Via dell'Università, Legnaro, Italy, ³Indena S.p.A., Milan, Italy.

Silymarin, the bioactive extract of *Silybum marianum*, is a natural hepatoprotector and a potent anti-hepatotoxic agent. In poultry, silymarin has shown to be effective against toxic effects of AFB₁, preventing the negative repercussions on performance of broilers. This study focused on the effects of silymarin on serum biochemistry in AFB₁ intoxicated broiler chickens. Twentyone 14-d-old male commercial broilers (377±34g body weight) were randomly allotted into 3 groups and treated for 35 days as follows: control group on a basal diet alone; AFB₁ at 0.8mg/kg of feed; AFB₁ at 0.8mg/kg of feed plus silymarin PHYTOSOME*, a silymarin complexed form with phospholipids from

soy, at 600 mg/kg body weight. Before slaughter, blood samples were collected from the brachial vein and total protein, albumin, globulin, glucose, urea, total bilirubin, direct bilirubin, indirect bilirubin, aspartate amino transferase (AST), gamma glutamil transferase (GGT), alanine amino transferase (ALT), calcium, and phosphorus were analyzed on sera. No differences were evidenced in any of the biochemical parameters evaluated, except for the level of ALT. The serum ALT activity was lower ($P<.05$) in AFB₁ treated animals with respect to control (6.16 vs 18.65 U/L, SEM=3.12). In animals receiving AFB₁ plus silymarin PHYTOSOME there was no difference in ALT serum activity in respect to control (26.14 vs 18.65 U/L, SEM=3.12). The decrease in serum ALT content is due to a recognized hepatotoxic effect of AFB₁. We can affirm that silymarin PHYTOSOME prevented these change in ALT activity, supporting the suggestion that these compound may achieve a protection against toxic effects of AFB₁. *PHYTOSOME is a trademark of Indena S.p.A.

Key Words: Aflatoxin B1, Silymarin PHYTOSOME, Serum Biochemistry

T89 Supplemental dietary 1,4-diaminobutane (putrescine) on growth and development of small intestine in broiler chicks challenge with *E. acervulina*. F. A. Santoyo¹, T. K. Smith*², and J. R. Barta², ¹Universidad Autonoma de Nuevo Leon, Monterrey, Mexico, ²University of Guelph, Guelph, ON, Canada.

Dietary putrescine (1,4-diaminobutane, DAB) the mammalian polyamine has been shown to play a regulatory role in growth, cellular development, division and anabolic processes including synthesis of DNA, RNA and protein. The high turn over rate of intestinal epithelium, as well as healing following mucosal damage resulting from luminal exposure to deleterious compounds or parasites, is dependent on sustained supplies of putrescine, spermidine and spermine. An experiment was conducted with one hundred and twenty eight, day-old male broiler chickens fed a corn and soybean meal based control diet. Experimental diets were formulated by adding putrescine (0.0, 0.15, 0.30 and 0.45%). Experimental diets and water were offered ad libitum for 21 days. Birds were housed at the Isolation Unit of the University of Guelph, in four rooms with 8 battery cages each with external drinker and feeder, with 4 birds/cage (4 diets with 2 cages per room each for a total of 8 birds/diet/room). On day 11, in each room 16 birds (4cages/4 birds/diet) were inoculated with *Eimeria acervulina* Guelph strain, with a dose of 1,000,000 oocysts per ml per bird. At day 17, and at day 21, the end of the experiment, 12 birds randomly selected by wing band number per diet were killed by cervical dislocation. Excreta were collected per pen in both rooms from days 11-13 for determination of fat and energy. Lesions in the small intestine were scored (0 to +4 scale). There was a significant quadratic increase in excreta fat content with increasing dietary putrescine in control birds. There was significant effect of diet on excreta energy content. Overall, the infection did influence growth rate and feed intake of broiler chicks, these levels of putrescine supplementation were inadequate to overcome the protozoal challenge.

Key Words: Polyamines, Putrescine, Coccidia

PSA - Immunology

T90 Development of an antigen specific indirect ELISA for *Eimeria* using recombinant antigen EASZ240 from *Eimeria acervulina*. K. Ameiss*¹, M. Jenkins², H. Danforth², A. Barri¹, and D. Caldwell¹, ¹Texas A&M University, College Station, ²USDA/ARS, Beltsville, MD.

The etiological agents of chicken coccidiosis are a number of *Eimeria* species including *E. acervulina*, *E. tenella* and *E. maxima*. While a cellular response to these parasites has been shown to be important, our laboratory is investigating the mucosal humoral response after both immunization and infection. In order to perform these studies an indirect ELISA was developed based upon the recombinant antigen EASZ240. EASZ240 was isolated from *E. acervulina* strain #12 and inserted into an expression vector containing both an arabinose promoter and a His tag for purification. This clone represents an immunodominant sporozoite surface antigen which also has high sequence homology to antigens from both *E. maxima* and *E. tenella*. The goal of this study was to develop and verify an indirect ELISA assay for the detection of antibodies to this antigen. The clone pBADSZ240 was grown using standard microbiological methods and then the protein purified using low pressure

chromatography with a Ni-NTA column. Purity was confirmed using SDS-PAGE. Positive control serum was obtained by hyper-immunizing chickens with the antigen and collecting and pooling serum. Mean absorbance of positive control serum as compared to normal chicken serum and pre-immune serum revealed a more than 20 fold increase when diluted at 1:2560. Validation of the assay was done by testing serum from birds challenged with both *E. acervulina* strain #12 and *E. tenella* WLR-1 strain. Mean absorbance revealed that, at six days post challenge, challenged birds (0.437 ± 0.03) were significantly ($P<0.001$) higher than non-challenged birds (0.15 ± 0.03). In addition birds immunized with Coccivac[®]-B revealed significantly higher ($P<0.001$) mean absorbance (0.33 ± 0.03) as compared to non-immunized birds (0.05 ± 0.01). These finding indicate that this indirect ELISA may be useful in examining the humoral response to *Eimeria* species.

Key Words: Indirect ELISA, *Eimeria*, Recombinant Antigen

T91 Dietary lutein and fat interact to modify macrophage nitric oxide production in chicks hatched from carotenoid depleted eggs. R. K. Selvaraj* and K. C. Klasing, *University of California, Davis*.

An experiment was conducted to study the interaction between dietary lutein and fat in broiler chicks hatched from lutein depleted eggs. Six dietary treatments in a 2 X 3 factorial (fat at 3 and 6% and lutein at 0, 25 and 50 mg /Kg feed) were fed to 18 birds per treatment (in 3 replications) for 23 days. Anti-DNP-KLH serum antibodies were measured on d 22 by ELISA. Peripheral blood monocytes were collected on d 17 for macrophage phagocytosis assay. On d 19, blood lymphocytes were stimulated with either Con-A or PHA-P and proliferation index was measured. On d 23, peripheral blood macrophages were stimulated with lipopolysaccharide in vitro and nitric oxide (NO) production was measured at 16 and 40 hours of stimulation. The anti-DNP-KLH serum antibody titer and macrophage phagocytotic index did not differ among treatment groups ($P > 0.05$). The Con A and PHA-P proliferation index was increased ($P < 0.05$) in birds fed 50 mg of lutein and 3% fat compared to all other treatments. Macrophage NO production at 16 hours was increased ($P < 0.05$) in birds fed lutein compared to the birds fed no lutein, independent of the level of dietary fat. Among the birds fed lutein at 25 or 50 mg/Kg feed, birds in the 3% fat group had increased NO production compared to the birds fed 6% fat group. At 40 hours, macrophage NO production in birds fed 25 and 50 mg lutein with 3% fat was increased ($P < 0.05$) compared to all other treatments. Thus, in birds hatched from lutein depleted eggs, modulation of macrophage NO production by lutein is dependent on the level of dietary fat.

Key Words: Lutein, Fat level, Macrophage

T92 Construction of a naïve chicken antibody library using phage display. Daad Abi-Ghanem*¹, Suryakant D. Waghela^{1,2}, and Luc R. Berghman², ¹*Department of Poultry Science, Texas A&M University, College Station*, ²*Department of Veterinary Pathobiology, Texas A&M University, College Station*.

Phage display technology has emerged in recent years as a powerful tool for the creation of antibody libraries. It is based on the possibility of linking the displayed antibody phenotype on the phage surface to the encapsulated genotype. This approach was used to create a naïve chicken combinatorial antibody library. Total RNA was extracted from the bursa of Fabricius of ten 9-week old Leghorn layers. Messenger RNA was purified and used for the synthesis of cDNA. First-strand cDNA was then used in a primary PCR to amplify VH and VL genes. The VH forward primer and the VL reverse primer included complementary linker sequences that were used in the secondary overlap PCR to link the VH (400 bp) and VL (350 bp) fragments, thus creating a single chain Fv fragment (scFv, 750-800 bp). The primers used in the overlap PCR incorporated the cloning sites of the restriction endonuclease *Sfi* I, thus allowing for subsequent cloning into the phagemid pComb3X vector (provided by Dr. C. Barbas, The Scripps Research Institute, CA). Vector and scFv were digested with *Sfi* I. Digests were loaded on a 1% agarose gel, and bands corresponding to the double-cut vector (3,400 bp), the stuffer fragment (1,600 bp), and the digested scFv (700 bp) were excised. Three ligation reactions using T4 DNA ligase were then carried out, including either insert and vector, vector and stuffer, or vector alone. Ligations were incubated overnight at room temperature, followed by transformation into XL1-Blue Supercompetent cells. Cells were plated onto LB/carbenicillin plates and incubated overnight at 37°C. About 5×10^7 transformants/ μ g of vector DNA were obtained from the vector-insert ligation. More than 10^8 cfu/ μ g of vector DNA were obtained from the vector-stuffer ligation, indicating good vector quality. Background ligation was determined by self-ligation of the vector, and was found to be minimal ($< 5\%$). The scFv antibody library thus produced will be used to select for antibodies that bind to surface antigens of chicken enteric pathogens.

Key Words: Phage Display, scFv, Chicken

T93 Cellular uptake of the triamilide tulathromycin by bovine and porcine phagocytic cells in vitro. T. W. Siegel¹, D. L. Earley², C. D. Smothers³, F. Sun¹, and A. P. Ricketts*¹, ¹*Pfizer Inc., Groton, CT*, ²*Pfizer Inc., Terre Haute, IN*, ³*Pfizer Inc., Kalamazoo, MI*.

Tulathromycin (Draxxin[®]) is the first of a new class of veterinary macrolide antimicrobial, the triamilides. This study explored the accumulation of tulathromycin by bovine and swine phagocytes in vitro. Bovine blood polymorphonucleocytes (PMNs) incubated in a range of tulathromycin concentrations from 0.5 to 5 μ g/ml concentrated the antibiotic to an internal/external (I/E) ratio of approximately 28. These antibiotic concentrations are within the plasma and lung tissue concentration ranges achieved in tulathromycin-treated animals. When tulathromycin-loaded bovine PMNs were transferred to antibiotic-free media, by 1 h 50% of the intracellular tulathromycin remained, and by 4 h 40% of the intracellular antibiotic remained intracellular. Bovine alveolar macrophages (M Φ) accumulated tulathromycin to a lesser extent (I/E = 19.3), as did porcine blood PMNs (I/E = 16.6) and porcine alveolar M Φ (I/E = 8.1). This pattern of accumulation is distinct from that of other macrolides. Recruitment of tulathromycin-loaded phagocytes to infected lungs could contribute to in vivo efficacy observed for this antibiotic in livestock. Accumulation of tulathromycin by bovine PMNs was influenced by time, temperature, pH, and formalin fixation, but was insensitive to metabolic inhibitors (NaF, KCN). Efflux of tulathromycin was slower than for erythromycin. An active carrier system has been proposed for macrolides and its molecular identity is under active investigation; for the tribasic tulathromycin reversible protonation of amines is probably also important in membrane penetration. In summary, the triamilide tulathromycin represents a new class of macrolide antibiotics that accumulates within phagocytes from cattle and swine; this may contribute to in vivo efficacy for this compound.

Key Words: Tulathromycin, Neutrophil, Macrophage

T94 Valine needs for immune responses in male broilers from day 21 to 42. S. A. Thornton*¹, G. T. Pharr¹, A. Corzo¹, S. L. Branton², and M. T. Kidd¹, ¹*Mississippi State University, Mississippi State*, ²*United States Department of Agriculture*.

A number of studies have evaluated the impact of Met, Arg, Lys, and Thr on immune responses of broilers. Although a limited amount of research exists evaluating Val needs for immunity in broilers, these studies point to its adequacy as being important to support normal immunity. Because Val can become limiting in broiler diets, especially those based on vegetable protein sources, two experiments were conducted to evaluate Val needs for cellular and humoral immunity in Ross 508 male broilers from 21 to 42 d. Birds in Experiment 1 were fed 3 dietary treatments with Val levels at 0.72%, 0.82% (accomplished by adding L-Val), and 0.82% (corn and soybean meal control equaling NRC (1994)). Experiment 1 measurements included: a hypersensitivity test to phytohemagglutinin-P (PHA-P) on d 35 and 36 (2 birds/pen); relative immune organ weights at d 42 (1 bird/pen); and a primary antibody response to SRBC on d 34 and 41 (2 birds/pen). Birds in Experiment 2 were fed 3 dietary treatments with Val levels at 0.64%, 0.73%, and 0.78%. Experiment 2 measurements included: a hypersensitivity test to Concanavalin A and Pokeweed mitogen on d 40 and 41 (2 birds/pen); relative immune organ weights at d 42 (1 bird/pen); a primary antibody response to SRBC on d 34 and 41 (2 birds/pen). Cell quantification of BU1 receptors on splenic cells at d 42 (1 bird/pen) was measured in treatments with 0.64% and 0.78% Val. In Experiment 1 there was a decrease ($P = 0.08$) for relative spleen weight in birds fed the 0.72% Val diet compared to birds fed the 0.82% corn and soybean meal control diet, however; significant differences did not occur for relative bursa and thymus weights. There were no significant differences in SRBC or PHA-P responses in Experiment 1. In Experiment 2, significant differences did not occur for any parameter tested. The results indicate that as CP is reduced in broiler diets to the extent of a marginal Val deficiency, the immune system of the birds should not be compromised.

Key Words: Broiler, Immunity, Valine

T95 Anti-rbosCD14 monoclonal antibodies (mAb) inhibits in vitro production of tumor necrosis factor- α (TNF- α) by bovine monocytes following stimulation with LPS. E. J. Sohn^{*1}, M. J. Paape², R. R. Peters¹, and D. D. Bannerman², ¹*Department of Animal and Avian Sciences, University of Maryland, College Park*, ²*Bovine Functional Genomic Laboratory, USDA-ARS, Beltsville, MD*.

Endotoxin (lipopolysaccharide, LPS) from Gram-negative bacteria activates host innate immune responses that promote bacterial clearance. Paradoxically, such a response also contributes to septic shock, a clinical problem occurring with high frequency during Gram-negative septicemia. CD14 is a glycoprotein which binds LPS and initiates cell activation. The production of TNF- α by monocytes stimulated with LPS is mediated, in part, by the interaction of LPS with CD14 on mono-

cytes. The objective of the present study was to investigate whether anti-rbosCD14 mAb could block the production of TNF- α by bovine monocytes stimulated with LPS. The concentration of LPS used ranged from 1 to 100 ng/ml. The inhibition of anti-rbosCD14 mAb on the LPS induced production of TNF- α by adherent monocytes during a 24 h of incubation was dose dependent. The greatest inhibition (61%) was achieved when 100 ng/ml of LPS was used to stimulate the monocytes. With 1 and 10 ng of LPS/ml, inhibition averaged 37% and 54%, respectively. The inhibition of TNF- α secretion by anti-rbosCD14 mAbs can be explained by the binding of mAb to membrane bound CD14 on the monocytes, thus blocking interaction of LPS with mCD14. The anti-rbosCD14 mAb has the potential for neutralization of TNF- α during acute coliform mastitis.

Key Words: Endotoxin, CD14, TNF- α

Companion Animals

T96 Serum and urine indice comparisons between llamas and alpacas fed three forages. M. Sharp^{*}, C. Horey, T. F. Robinson, and B. L. Roeder, *Brigham Young University, Provo, UT*.

The objective of this experiment was to determine species differences for serum and urine indices between llamas and alpacas fed three forages of differing quality. Four llamas (115 kg BW; 3yrs old) and four alpacas (58 kg BW; 3 yrs old) were housed in metabolic crates, given ad libitum water and grass hay initially. Three forage treatments of alfalfa (AH), barley (BH) and grass (GH) were fed in random order to each animal. Treatment periods were for 14 d; d1 to d12 for forage adjustment and d13 to d14 for collection. Animals were fitted with a urine collection harness and a jugular venous catheter. Forages were fed ad libitum and feed intake determined. Blood and urine were collected at 4-hr intervals on d13 and 14. Serum and urine aliquots were analyzed for electrolytes (Na, Cl, K, Ca and P), urea N, creatinine. Feed intake differed between species and forage ($P < .05$), alfalfa the highest and llamas consuming more than alpacas. Serum electrolytes, osm and creatinine were not different. Glucose levels were higher ($P < .01$) for llamas than alpacas, 7.7 to 7.2 mmol/L. Total serum protein was higher for llamas than alpacas ($P < .05$; 6.6 to 5.8 g/dL), while PUN was affected ($P < .01$) by forage: 7.8, 4.7 and 3.9 for AH, BH and GH. Urine results are expressed on a metabolic weight basis ($\text{kg}^{-.75}$). AH urine excretion was highest ($P < .005$) at 70.9, and 42.2 and 32.8 ml/d/mwt for BH and GH. Urine electrolyte excretion differed for diet ($P < .05$; Na: 3.0, 3.6, 1.6 mmol/d/ $\text{kg}^{-.75}$; Cl: 27.2, 22.1, 18.9 mmol/d/ $\text{kg}^{-.75}$; K: 11.4, 5.9, 6.1 mmol/d/ $\text{kg}^{-.75}$ for AH, BH and GH). PUN excretion differed for species, forage and the interaction ($P < .03$), 281, 126 and 87 mmol/d/ $\text{kg}^{-.75}$ for AH, BH and GH and 189 vs.140 mmol/d/ $\text{kg}^{-.75}$ for llamas and alpacas. Creatinine excretion was not different. It has been hypothesized that llamas and alpacas are similar in physiology and respond to diets in a similar fashion. These data demonstrate that the two species responded similarly to the three forages, with the exception of serum glucose and total protein and urine urea N. Diet did affect urine indices.

Key Words: Alpaca, Llama, Forages

T97 Affect of water deprivation on plasma and urine analytes of alpacas. A. Peterson^{*}, J. A. Anderson, T. F. Robinson, and B. L. Roeder, *Brigham Young University, Provo, UT*.

Four male alpaca (62 kg BW, 3 yrs old) were housed in metabolism crates and given ad libitum water and grass hay. The alpacas were fitted with a urine collection harness and a jugular catheter. Urine and plasma were collected at 4-hr intervals during the 14 d baseline, 120-hr water dehydration (Dh) and 160-hr rehydration (Rh) periods. Plasma and urine were analyzed for electrolytes (Na, Cl, K and Ca), total protein, urea N and creatinine. Data are presented as a mean of the baseline samples at the 4-hr interval times, while Dh and Rh data were analyzed as repeated measures using SAS Proc Mixed. Water intake was 24.4 ml/d/ $\text{kg}^{-.75}$ while urine output was 7.1 ml/d/ $\text{kg}^{-.75}$. Pack cell volume increased ($P < .001$) during Dh from 24 to 32%, returning to 23% for Rh. Plasma osm increased ($P < .001$) from 312 to 356 mmol/kg with the Dh/Rh, while COP increased ($P < .001$) from 21 to 24 mmHg. Plasma electrolytes increased ($P < .001$). Na and Cl increased from 149 and 121 mmol/L to 161 and 133 mmol/L, respectively. K increased from

4.9 to 5.4 mmol/L ($P < .001$). Glucose increased ($P < .001$) from 7.1 to 8.4 mmol/L, with PUN increasing from 2.7 to 8.6 mmol/L ($P < .001$). Creatinine was not affected and TPP increased ($P < .001$) from 5.6 to 6.1 g/dL. Urine osm increased from 1100 to 1800 mmol/kg ($P < .001$). Urine electrolyte excretion was affected by Dh. Na increased from 0.30 to 1.30 mmol/d/ $\text{kg}^{-.75}$. Cl was unchanged during Dh and increased from 1.5 (baseline and Dh) to 3.0 mmol/d/ $\text{kg}^{-.75}$ during the Rh period. K decreased from 1.1 to 0.13 mmol/d/ $\text{kg}^{-.75}$ during the Dh period. PUN excretion increased from 5.7 to 12.5 mmol/d/ $\text{kg}^{-.75}$, and creatinine increased from 1.1 to 8.0 mg/d/ $\text{kg}^{-.75}$ ($P < .001$). Alpacas respond similarly to Dh/Rh as do llamas, with the exception being increased urine urea N excretion. This implies that alpacas do not recycle urea N to Cl during Dh. Glucose may have been elevated from endogenous glucocorticoid release during Dh and during Rh rebounded due to realimentation. Rh elicited a diuresis affect with increased Na and very large Cl excretion.

Key Words: Alpaca, Dehydration, Analytes

T98 Affect of water deprivation on plasma and urine analytes of llamas. J. A. Anderson^{*}, A. Petersen, T. F. Robinson, and B. L. Roeder, *Brigham Young University, Provo, UT*.

Four male llama (123 kg BW, 3 yrs old) were housed in metabolism crates and given ad libitum water and grass hay. The llamas were fitted with a urine collection harness and a jugular catheter. Urine and plasma were collected at 4-hr intervals during the 14 d baseline, 120-hr water dehydration (Dh) and 160-hr rehydration (Rh) periods. Plasma and urine were analyzed for electrolytes (Na, Cl, K and Ca), total protein, urea N and creatinine. Data are presented as a mean of the baseline samples, while the Dh and Rh data were analyzed as repeated measures using SAS Proc Mixed. Water intake was 17.8 ml/d/ $\text{kg}^{-.75}$ while urine output was 3.7 ml/d/ $\text{kg}^{-.75}$. Pack cell volume increased ($P < .001$) during the Dh period from 24 to 28%, returning to 23% for Rh. Plasma osm increased ($P < .001$) from 315 to 354 mmol/kg with the Dh/Rh, while COP increased ($P < .001$) from 22 to 24 mmHg. Plasma electrolytes increased ($P < .001$) with the exception of K. Na and Cl increased from 151 and 125 mmol/L to 166 and 133 mmol/L, respectively. Glucose increased ($P < .001$) from 6.6 to 7.7 mmol/L, with PUN increasing from 4.3 to 7.8 mmol/L ($P < .001$). Creatinine was not affected. Urine osm increased from 2500 to 3000 mmol/kg ($P < .001$). Urine electrolyte excretion was affected by Dh. Na increased from 0.11 to 1.40 mmol/d/ $\text{kg}^{-.75}$. Cl was unchanged during Dh and increased from 2.5 (baseline and Dh) to 6.0 mmol/d/ $\text{kg}^{-.75}$ during Rh. K decreased from 1.1 to 0.4 mmol/d/ $\text{kg}^{-.75}$ during Dh. PUN excretion was not affected by Dh, while creatinine increased from 0.6 to 9.4 mg/d/ $\text{kg}^{-.75}$ ($P < .001$). These data indicate that llamas respond to Dh/Rh with similar increases followed by decreases in PCV, PUN, plasma Na, urine Osm, and urine electrolytes. Exceptions were plasma K and creatinine which did not change. Glucose may have been elevated from endogenous glucocorticoid release during Dh and during Rh rebounded due to realimentation. Rh elicited a diuresis affect with increased Na and very large Cl excretion. Unlike other species during Dh, llamas recycle large quantities of urea N to Cl, avoiding pre-renal azotemia.

Key Words: Llama, Dehydration, Analytes

T99 Differential expression of mitochondrial and extra-mitochondrial proteins in heart of low and high feed efficient broilers within a single male line. N. Tinsely*¹, M. Iqbal¹, N. R. Pumford¹, K. Lassiter¹, C. Ojano-Dirain¹, J. P. Higgins¹, W. Bottje¹, T. Wing², and M. Cooper², ¹*Department of Poultry Science, Center of Excellence for Poultry Science, University of Arkansas, Fayetteville, 2Cobb-Vantress, Inc., Siloam Spring, AR.*

The objectives of this study were to determine the relationships of low or high feed efficiency (FE) with expression of mitochondrial and extra-mitochondrial proteins, and protein oxidation in heart muscle. Tissue homogenate was prepared from hearts of broilers with High (0.80 ± 0.01 , $n = 7$) and Low FE (0.62 ± 0.02 , $n = 5$). The levels of specific electron transport chain (ETC) immunoreactive proteins and protein oxidation (carbonyls) were analyzed using Western blots with a chemiluminescence detection system. A proteome from the pooled heart muscle homogenate in each group was obtained using two-dimensional electrophoresis (2DE). The intensity of each protein spot was quantified using Image Master 2D software. The expression of six mitochondrial proteins [CII 70 S (Complex II), ISP, cyt b, cyt c1 (Complex III), COX II (Complex IV)] and adenine nucleotide translocator 1 (ANT1) were higher in low FE heart mitochondria, but one protein [NAD6C (Complex I)] was higher in high FE birds, and there were no differences between groups in the expression of 18 other respiratory chain proteins. The levels of protein carbonyl (protein oxidation) were higher in the heart of low compared to high FE broilers. 2DE revealed several proteins that were differentially expressed between the low and high FE groups. These findings of differential expression of some mitochondrial and extramitochondrial proteins in Low FE tissues are similar to a recent report in breast muscle (Iqbal et al., 2004, *Poult. Sci.* 83:474-484) and may either be due to inherent genetic differences or represent a compensatory response to overcome the increased protein oxidation in low FE birds. Funded in part by USDA-NRI grant (#2001-03443).

Key Words: Feed Efficiency, Mitochondrial Proteins, Protein Oxidation

T100 Differential expression of mitochondrial and extra-mitochondrial proteins in lymphocytes of low and high feed efficient broilers within a single male line. K. Lassiter*¹, M. Iqbal¹, N. R. Pumford¹, C. Ojano-Dirain¹, N. Tinsley¹, W. Bottje¹, T. Wing², and M. Cooper², ¹*Department of Poultry Science, Center of Excellence for Poultry Science, University of Arkansas, Fayetteville, 2Cobb-Vantress, Inc., Siloam Springs, AR.*

The objectives of this study were to establish relationships of a) mitochondrial and extramitochondrial protein expression, and b) protein oxidation (carbonyls) in lymphocytes with feed efficiency (FE) in broilers. Lymphocytes were isolated from a single line of male broilers with low (0.48 ± 0.02 , $n=8$) and high (0.68 ± 0.01 , $n=7$) FE. Protein bands were separated by electrophoresis (10% SDS-PAGE) and stained with Coomassie Blue. The band intensities were scanned with an Agfa (Arcus II) scanner and quantified using Scion software. Mitochondrial proteins, and oxidized protein (carbonyls) were analyzed using Western blots with chemiluminescence detection. A proteome from the pooled lymphocyte homogenate in each group was obtained using two-dimensional electrophoresis (2DE). The intensity of each protein spot was quantitated using Image Master 2D software. The expression of three mitochondrial proteins (core I, cyt c 1 [Complex III], and ATPase [Complex V]) were higher and lower for one protein (CII 30 [Complex II]) in High FE compared to Low FE lymphocytes, but there were no differences between groups for six other proteins. 2DE analysis showed a difference in the expression of several other proteins between groups. The levels of protein carbonyl were higher in High compared to Low FE birds. These results extend our reports in several tissues including breast muscle (Iqbal et al., 2004, *Poult. Sci.* 83:474-484) indicating that differences in protein expression may be involved in the phenotypic expression of feed efficiency. Supported in part by USDA-NRI grant (#2001-03443).

Key Words: Feed Efficiency, Lymphocytes, Mitochondrial Proteins

T101 Steady-state levels of mitochondrial phosphoproteins in broilers with and without pulmonary hypertension syndrome. C. R. Cisar*¹, J. M. Balog¹, J. O. Lay Jr.², N. B. Anthony², and A. M. Donoghue¹, ¹*Poultry Production & Product Safety, ARS, USDA, Fayetteville, AR, 2University of Arkansas, Fayetteville.*

Pulmonary hypertension syndrome (PHS), also known as ascites syndrome, is a metabolic disease associated with the rapid growth rate of modern broilers. PHS symptoms include chronically elevated pulmonary blood pressure leading to right ventricular hypertrophy and eventually heart failure. Broilers resistant to PHS have elevated levels of several mitochondrial electron transport chain proteins in their right ventricles. Phosphorylation of mitochondrial proteins regulates respiratory activity and other mitochondrial functions. Therefore, we examined steady-state levels of mitochondrial phosphoproteins in broilers with and without PHS. Mitochondria were prepared from right ventricle cardiac muscle and mitochondrial proteins were separated by two-dimensional gel electrophoresis. Gels were stained with Pro-Q Diamond[®], a fluorescent phosphoprotein-specific stain, and images were acquired using a laser scanner. Twenty putative phosphoproteins were detected. Four of these proteins appeared to be less phosphorylated in broilers without PHS than in broilers with PHS. Two proteins appeared to be more phosphorylated in broilers without PHS than in broilers with PHS. We are currently attempting to identify these six phosphoproteins from their peptide mass fingerprints as determined by MALDI-TOF mass spectrometry.

Key Words: Pulmonary Hypertension Syndrome, Mitochondria, Phosphoprotein

T102 Aorta pulse wave velocity is reduced by intravenous injections of L-arginine in female, but not male, white leghorn chickens. C. A. Ruiz-Feria*¹ and H. Nishimura², ¹*McGill University, Ste. Anne de Bellevue, QC, Canada, 2University of Tennessee, Memphis.*

Chickens (males more so than females) have higher blood pressure that most mammals and develop neointimal lesions in the distal abdominal aorta (AbA). We found that L-arginine (Arg) reduced neointima plaque size in chicks (6-10 wks), but increased plaque size in older birds (12-16 wks), presumably due to endothelial damage in older birds. We evaluated the effect of an i.v. injection of Arg (160 mg/kg BW) on pulse wave velocity (PWV, m/s), mean arterial pressure (MAP, mm Hg) and pulse pressure (PP, systolic-diastolic BP, mm Hg) in 13-wk-old anesthetized male ($n = 7$) and female birds ($n = 9$). A Mikrotip[®] catheter with two intravascular pressure transducers was advanced to the AbA and pressure waves electronically recorded. PWV was calculated as the distance between the two transducers divided by the time delay at the foot of a pulse wave recorded at the two transducers. Data was analyzed using a one way repeated measure ANOVA, and significance declared at $P < 0.05$. PWV, MAP, and PP were not different between male and female chickens before Arg injection (control). In females, PWV increased 30 s after Arg (11.4 ± 0.9 Vs 13.2 ± 0.8), returned to control levels between 60 and 90 s, was lower than control levels after 120 s (8.0 ± 0.7), and returned to control levels after 11 min. PWV in males did not change with Arg. In females, MAP was lower 120 sec after Arg (87.5 ± 4.9) compared with control levels (100.0 ± 5.3), and remained lower up to 15 min after Arg. Again, no change was observed in males. PWV and MAP were lower in females than in males from 120 sec through 11 min after Arg. PP increased in both male (31.4 ± 3.1 and 43.5 ± 4.6 , before and 120 s after Arg, respectively) and female (26.1 ± 2.4 and 43.3 ± 2.6 , in the same order) chickens, but in males PP returned to control levels after 11 min whereas in females PP remained higher up to 15 min after Arg. Age-matched male and female chickens show a different response in aortic elasticity parameters to Arg, and this may be related to differences in endothelial integrity and capacity to synthesize nitric oxide.

Key Words: Pulse Wave Velocity, L-Arginine, Nitric Oxide

T103 Pulmonary and systemic hemodynamic responses to prostacyclin in broilers. R. F. Wideman* and M. E. Chapman, *University of Arkansas, Fayetteville.*

The vasodilator prostacyclin (PGI₂) reduces the resistance to pulmonary blood flow and attenuates pulmonary hypertension in mammals, however no information is available regarding the responsiveness of the avian pulmonary vasculature to PGI₂. Accordingly, in three experiments we evaluated the pulmonary vascular responses to PGI₂ in male broilers. In Experiment 1, infusing PGI₂ (10 µg/min) into clinically healthy broilers did not reduce their pulmonary vascular resistance (PVR) but did reduce the pulmonary arterial pressure (PAP) by lowering the cardiac output (CO). Within 4 min after stopping the PGI₂ infusion, the CO and PAP returned to pre-infusion levels. In Experiment 2, the responses to PGI₂ were evaluated after arachidonic acid (AA) had been infused to pre-constrict the pulmonary vasculature. The AA infusion (400 µg/min) consistently triggered dramatic, sustained pulmonary vasoconstriction (increased PVR) and pulmonary hypertension (increased PAP). Concurrent PGI₂ infusions did not reduce the PVR, but did reduce the PAP by lowering the CO. After the PGI₂ infusion was terminated, the PAP and CO returned to their previous (hypertensive) levels attributable to the ongoing AA infusion. In Experiment 3, PGI₂ was infused into clinically healthy (PAP ≤24 mmHg) or sub-clinically hypertensive (PAP ≥27 mmHg) broilers. Throughout this experiment broilers in the hypertensive group had higher PAP values than broilers in the healthy group. The PGI₂ infusion reduced the PAP in both groups, but did not reduce the PVR. Instead, the pulmonary hypotension in response to PGI₂ infusion was associated with a reduction in CO in both groups. In each of these experiments PGI₂ reduced the PAP by reducing the CO rather than by reducing the PVR. There was no evidence that PGI₂ acts as an effective pulmonary vasodilator in broilers regardless of whether their pulmonary vasculature was apparently normal (clinically healthy), had been pharmacologically pre-constricted (AA infusion), or initially exhibited the vasoconstriction that is typical of the pathogenesis of pulmonary hypertension syndrome in broilers.

Key Words: Broilers, Prostacyclin, Hemodynamics

T104 Pulmonary hypertensive responses of broilers to lipopolysaccharide: evaluation of source and dose, and impact of pre-existing pulmonary hypertension and cellulose micro-particle selection. M. E. Chapman*, W. Wang, and R. F. Wideman, *University of Arkansas, Fayetteville.*

Previous studies show that bacterial lipopolysaccharide (LPS) triggers pulmonary vasoconstriction leading to pulmonary hypertension (PHS) in broilers. The lungs of broilers are constantly challenged with LPS that can trigger thromboxane A₂- and serotonin-mediated pulmonary vasoconstriction. Among broilers from a single genetic line, some individuals respond to LPS with large increases in pulmonary arterial pressure (PAP), whereas others fail to exhibit a response to the same supra-maximal dose of LPS. It is possible that broilers are more likely to exhibit pulmonary hypertension when LPS elicits the production of more vasoconstrictors than vasodilators such as nitric oxide. In the present study we evaluated the impact of a variety of factors on the magnitude of the PAP response of male broilers to LPS, including: a) The role of the initial PAP (Low vs. High initial PAP); b) The source of the LPS (*S. typhimurium* vs. *E. coli*); c) The dose of LPS (0.02, 0.1, and 0.5 mg/kg BW); and d) The role of micro-particle selection for improved pulmonary vascular capacity (Cellulose survivors vs. Saline controls). Broilers with a low initial PAP did not differ in their pulmonary hypertensive response to LPS when compared with broilers having a high initial PAP. LPS from *S. typhimurium* elicited pulmonary hypertensive responses similar to those elicited by *E. coli* LPS. The results revealed that a dose of 0.1mg/KgBW LPS elicits a maximal pulmonary hypertensive response in broilers, and broilers selected for a robust pulmonary vascular capacity by micro-particle injection did not differ in their pulmonary hypertensive response to LPS when compared with saline injected controls. This confirms that the variable pulmonary hypertensive responses among broilers cannot be attributed to the source or dosage of LPS, or to differences in the baseline PAP or micro-particle selection prior to injecting LPS. This is consistent with the hypothesis that innate rather than acquired variability influences the chemical mediators released during the inflammatory cascade.

Key Words: Ascites, Vasoconstriction, LPS

T105 Effect of selection of sires and dams for growth or egg production on embryonic cardiac physiology. V. L. Christensen*, D. T. Ort, J. L. Grimes, and M. J. Wineland, *College of Agriculture & Life Sciences, North Carolina State University, Raleigh.*

Poult cardiac tissue may appear normal at hatching, yet ventricular hypertrophy can increase the size of the heart and confers a round shape called spontaneous cardiomyopathy (SCM). The SCM might result from selection for economically important traits. The hypothesis was proposed that lines selected for increased egg production (Egg) or body weight (F) might affect embryo cardiac physiology. Lines of turkeys selected for either trait as well as their randombred control populations (R1 and R2, respectively) were studied. At sexual maturity, hens were assigned randomly to pens by line. Half of each line was mated to males of the same line whereas the remaining half was mated to males of the appropriate randombred strain in reciprocal crosses. Progeny resulting from the crosses were observed for heart rate and weight, cardiac glycogen and lactate concentrations and creatine kinase (CK) and lactate dehydrogenase (LDH) activities that are indicators of cardiac insufficiency. Data were analyzed comparing dam and sire effects of the Egg only with the R1 and the F only with R2. In the Egg/R1 comparison, Egg dams increased embryo heart rate compared to R1 and also depressed embryo heart weight compared to R1 dams. Sire effects were negligible. Tissue oxygen debt was indicated in poults from R1 dams and Egg sires at hatching. F sires and dams compared to R2 decreased embryonic heart rates and increased heart weights, but when observed relative to body mass, F sires increased heart weights. Selection for growth in dams decreased tissue oxygen debt as indicated by CK. Thus, selection for egg production has increased heart rates and depressed weights relative to body mass. F embryo tissue oxygen debt and reduced heart rates were also evident. Selection for growth also decreased poult tissue oxygen debt for 3 days posthatching. In conclusion, the data indicate that selection for both egg production and growth have affected embryo cardiac physiology divergently and may play roles in the increased incidence of SCM in turkeys.

Key Words: Turkey, Embryo, Heart

T106 Effect of excess dietary vitamin D supplementation as a management adjustment to reduce the effect of heat stress on three varieties of laying hens. D. J. Franco*, L. Robeson, and M. M. Beck, *University of Nebraska, Lincoln.*

Thirty-two hens of each strain (Brown, W98, W36) were randomly selected and allowed to acclimatize for two weeks at 22C. Sixteen birds from each strain received a commercial layer diet plus 22,000 IU/Kg feed of vitamin D₃; the rest of the birds were fed the commercial layer diet. Birds were exposed to heat stress (HS) at 35C for two weeks with two additional weeks at 22C to recover. Production parameters (PP), mortality rates (MR) and reproductive hormone levels (RHL) were measured for each phase. Acid base status (AB) and intestinal calcium uptake rate (CaT) data were obtained from samples collected before and during HS exposure. The data for PP and RHL were analyzed using the SAS program 1999 version 8.0 as a repeated measure ANOVA in a 3x3x2 factorial experiment with a level of significance of 0.1. The data for CaT, and AB were analyzed in a 3x2x2 factorial experiment with a level of significance of 0.05. Differences among means were obtained based on LSD test. The results showed less decrease in egg production (EP) during HS in all the varieties given the extra vitamin D₃ than birds receiving the regular diet. The rest of PP were negatively affected by HS with small differences among strains and diet. Blood pH and PO₂ levels increased, with a reduction in PCO₂ and HCO₃ levels in the three strains during HS. LH and estrogen blood levels were significantly lower during HS for the three strains, and progesterone levels showed a large increase after HS exposure. CaT was enhanced by vitamin D₃ during HS with the W36 and the W98 showing the higher rate compared to the Browns. Based on these results we can conclude that the addition of excess dietary vitamin D₃ in the diet did not reduce the effect of HS on egg weight, eggshell quality and other PP. However, the addition of this vitamin in the diet allowed the birds to maintain high EP and CaT. Even though vitamin D₃ improved CaT, utilization of calcium was not increased, likely because of the alkalosis noted, which was not affected by vitamin D₃.

Key Words: Laying Hens, Heat Stress, Vitamin D₃

T107 Heat stress suppresses 3 β -hydroxysteroid dehydrogenase activity differentially by strain in granulosa cells of laying hens. H. Taira* and M. M. Beck, *University of Nebraska, Lincoln.*

Heat stress (HS) is known to disrupt egg production and to suppress circulating progesterone (P₄), luteinizing hormone (LH), and estrogen. It has been shown that strain differences exist in response to HS (Franco et al., 2002, 2003). HS suppresses secretion of P₄ by granulosa cells (GC) *in vitro*, even when stimulated by addition of LH (Novero et al., 1990), and decreases activity of 3 β -hydroxysteroid dehydrogenase (3 β -HSD) in GC of laying hens (Alodan, 2001) and in testis of Japanese quail (Taira et al., 2003). In this study, two experiments were conducted to determine the effects of HS on estrogen receptor- α (ER α) localization and 3 β -HSD activity. Comparisons were made among 3 types of Hy-Line hens (W-36, W-98 and Brown), with birds of each strain divided into 3 groups: thermoneutral (22C, 50% RH; TN), acute (A) HS (36C, 50% RH; 24h), and chronic (C) HS (36C, 50% RH; 2wk) conditions. Effect of HS on ER α staining in kidney, duodenum and shell gland by immunocytochemistry was inconclusive. Activity of 3 β -HSD was determined by incubating GC in the presence of pregnenolone and nitroblue tetrazolium. To determine percentage of 3 β -HSD active cells, a total of 200 cells per bird was counted. 3 β HSD activity was suppressed by both AHS or CHS; AHS reduced 3 β -HSD by 42.6% (P<0.01) and 36.2% (P<0.01), respectively compared to TN. Under CHS, 3 β -HSD activity was lower in GC from Brown birds compared to W-98 (P<0.01); activity in cells from W-36 birds was intermediate. In addition, in Brown hens, CHS suppressed 3 β -HSD to a greater extent than did AHS (P<0.01). The results of the 3 β -HSD study suggest a possible mechanism by which the strain effects of HS may be mediated; earlier studies have shown that W-98 hens maintain production significantly better than either W-36 or Browns and that W-36 are always intermediate in response between W-98 and Browns. Because P₄ is the main ovarian ovulatory/oviposition hormone in birds, decreased activity of 3 β -HSD by HS, particularly since it is differentially suppressed by strain, may be a logical point at which to investigate genomic aspects of the response.

Key Words: 3 β -HSD, Granulosa Cells, Heat Stress

T108 Duration of follicular development increases with advancing duration of the reproductive period in broiler breeder hens. H.-K. Liu* and W. L. Bacon, *The Ohio State University, Wooster.*

Settable egg production of broiler breeder hens is increased by feed restriction, but declines as the duration of the reproductive period increases. We hypothesized that the decrease in egg production with advancing duration of the reproductive period is associated with a longer duration of follicular development. The objective of the current study was to document the duration of ovarian follicular development early (Early, at 3 to 6 wk of egg production) and late (Late, after egg production had declined by about 25% at 19 to 31 wk of egg production) in broiler hens that were full-fed during both growth and reproductive periods (FF), restricted-fed during growth but full-fed after photostimulation (RF), or restricted fed during both growth and reproduction periods (RR). Photostimulation was at 23 wk of age. Sudan IV (R; 100 mg/hen/d) and Sudan Black B (B; 50 mg/hen/d) were suspended in canola oil and 1.0 mL day fed alternatively to measure the duration of follicular development. The total egg production rate (74-84% and 52-56%, respectively) was not different between feeding treatments within Early and Late hens. The duration of ovarian follicular development (8.7-9.1 d and 9.8-10.2 d, respectively) was not different between feeding treatments within Early and Late hens. Early hens in each feeding treatment had a higher (P<0.01) total egg production rate but shorter (P<0.005) duration of follicular development in comparison to Late hens. We concluded that longer duration of ovarian follicular development in Late hens was associated with lower total egg production rate in broiler breeder hens.

Key Words: Follicle, Broiler, Feed Restriction

T109 Bone characteristics of laying hens as a function of age, diet and strain. J. Wardell*, N. Heywood, and M. M. Beck, *University of Nebraska, Lincoln.*

Many factors have been investigated, but none have been shown to function alone in the etiology of osteoporosis in the hen. The occurrence of

medullary bone as the labile calcium reserve for shell formation complicates the picture. Trabecular bone is found in the middle of the ends of the long bones and in the vertebrae and contributes more to stress resistance. The partitioning of bone between medullary and trabecular components is of interest. Comparisons between younger (first egg) and older birds (70-72 wk) indicate that medullary bone formation and remodeling occur partly at the expense of trabecular bone (Whitehead, 1991). In this study, two strains of Hy-Line birds, W36 and W98, were started as chicks receiving NRC requirement diets or a diet supplemented with HyD[®]. Chicks were fed to achieve target body weight or 15% greater or less than target. Bones were sampled at 20 and 60 wk of age. The right tibia from two birds in each treatment was removed, cleaned, decalcified, cut into eight pieces (two halves of the proximal head, four pieces of the shaft, two halves of the distal end), embedded in paraffin, sectioned at 7 μ m, and stained with hematoxylin and eosin. Two slides per bird were used for histological examination and measurement of cortical bone diameter and percent trabecular bone. Cortical diameter (CD) was measured at one location on both sides of the bone; percent trabecular bone (%TB) was obtained by dividing TB area by total bone area. Measurements were made using Scion Image analysis program. Data were analyzed using SAS. Comparisons were age (A), strain (S), body weight (BW), and diet (D). For cortical bone, there were effects of age, SxBW, SxD, and AxBWxD. At 60 wk, CD was less than at 20 wk (P=0.0001). At 20 wk, addition of HyD[®] enhanced CD in W36 birds but not in W98; at 60 wk, there was no effect of D but W98 birds had greater CD than W36 birds (P=0.0175). For %TB, there were effects of A, S, BW, D, AxBW, SxBW, AxBWxD, SxD, BWxD, and AxBWxD. Considering the most complex interaction, it appeared that S, BW and A contributed most to %TB, and that there was relatively little effect of D.

Key Words: Osteoporosis, Trabecular Bone, Cortical Bone

T110 Yolk-related gene transcription by estrogen in the liver of Japanese quail. A. M. Hanafy^{1,2}, T. Sasanami¹, and M. Mori^{*1}, ¹Shizuoka University, Shizuoka, Japan, ²United Graduate School of Agricultural Science, Gifu University, Gifu, Japan.

The avian liver is known as a target tissue for estrogens. In the previous study, we have demonstrated that diethylstilbestrol stimulates the expression of ZP1, perivitelline membrane glycoprotein, in the liver of immature male quail, and ZP1 gene has been shown to be a sensitive biomarker for estrogenic compounds. In the present study, we compared the sensitivity of transcription of ZP1 with those of vitellogenin II (VTG II) and very-low-density apolipoprotein II (apoVLDL). Immature male quail were treated with single intraperitoneal injection of estrogenic compounds dissolved in corn oil. Total RNA extracted from liver was reverse-transcribed with oligo (dT) primers. The cDNA was subjected to real-time PCR performed with the gene-specific sets of primers (ZP1: AB061520, VTG II: AF499027, apoVLDL: S82591, GAPDH: Z19086) and TaqMan probes. Cycling conditions were 10 min at 95°C followed by 40 cycles of 15 sec at 95°C and 1 min at 60°C. The standard curves were almost linear between 10⁹ to 10⁵ copies for all genes. Levels of mRNA of each gene were expressed in relation to house-keeping GAPDH mRNA levels. Expression of ZP1, VTG II, and apoVLDL genes are highly specific for mature female, and no significant expression was observed in the mature and immature male quail. Of the three female-specific genes measured, apoVLDL was the most sensitive for estrogenic compounds. Administration of ethinyl estradiol or diethylstilbestrol at 1 μ g per 100 g body weight caused more than a ten-fold increase in the mRNAs. All three genes were induced by ethinyl estradiol or diethylstilbestrol at 100 μ g per 100 g body weight, although the increase in the mRNA was prominent only one day after the administration. The present study shows that effects of estrogenic compounds vary in the induction of female-specific gene transcription, and apoVLDL was more responsive to the estrogenic compounds than ZP1 and VTG II as a biomarker gene. These results suggest that the expression of avian female-specific genes may be differentially regulated.

Key Words: Liver, Estrogen, Vitellogenesis

T111 Identification of endocrine phenotypes of chicken pituitary cells expressing the vasotocin VT2 receptor subtype. A. Jurkevich^{*1}, L. R. Berghman², L. E. Cornett³, and W. J. Kuenzel¹, ¹Department of Poultry Science, University of Arkansas, Fayetteville, ²Poultry Science Department, Texas A&M University, College Station, ³University of Arkansas for Medical Sciences, Little Rock.

Hypothalamic neurohormones of vasotocin/vasopressin family have long been shown influencing the endocrine and behavioral response to stress. The regulatory effects of these hormones are achieved by modulating neuronal processes in the brain and by controlling hormone release from the pituitary gland. Effects of vasotocin (VT) on pituitary hormones in the domestic fowl are mediated, at least in part, by the VT2 vasotocin receptor highly expressed in the pituitary. Immunohistochemical localization of VT2 receptor-expressing cells revealed that they are prevalent in the cephalic lobe of the anterior pituitary. The objective of this study was to identify the endocrine phenotypes of chicken pituitary cells containing immunoreactive VT2 receptor protein using a dual labeling immunohistochemical approach. The obtained results confirmed our previous finding that, at the subcellular level, the VT2 receptor is predominantly associated with the cell membrane. Dual immunofluorescent labeling demonstrated that virtually all corticotrophs are VT2 receptor-immunoreactive. The immunoreactive VT2 receptor was also found in a relatively small subpopulation of lactotrophs. Preliminary assays did not reveal extracellular membrane-associated VT2 receptor on gonadotrophs (visualized with the antibody to chicken LH β -subunit) and somatotrophs; however these findings are being verified on a larger amount of samples. Our results provide the first morphological evidence supporting the hypothesis that VT could be the primary ACTH secretagogue in birds acting directly on corticotrophs. Moreover, the data obtained suggest that the known stimulatory effects of VT on prolactin release in poultry species are likely to be mediated primarily by VT2 and perhaps other VT receptor subtypes.

Key Words: Vasotocin, Pituitary Gland, Stress

T112 Characterization and expression of the avian ghrelin gene. M. Richards^{*}, S. Poch, and J. McMurtry, *USDA, ARS, Growth Biology Laboratory, Beltsville, MD.*

Ghrelin (GHR), a peptide hormone produced by the stomach in mammals, stimulates growth hormone (GH) release and food intake. Recently, GHR was identified and characterized in chicken proventriculus and shown to stimulate GH release but inhibit feed intake. The purpose of this work was to identify and characterize the GHR gene in Leghorn (LC) and broiler (BC) chickens and in turkeys (T). Using molecular cloning techniques we have sequenced cDNAs corresponding to LC and T GHR mRNAs. A total of 844 (LC) or 869 (T) bases including the complete coding regions (CDS), and the 5'- and 3'-untranslated regions (UTRs) were determined. Nucleotide sequence (CDS) predicted a 116 amino acid precursor protein for both LC and T that demonstrated complete conservation of an N-terminal active core (GSSF) including a serine (position 3) known to be a modification (acylation) site important for GHR bioactivity. Additional nucleotide sequence was found in the 5-UTRs of both LC and T cDNAs that was not present in BC. The T GHR gene, sequenced from genomic DNA templates, contained 5 exons and 4 introns, a structure similar to mammalian and chicken GHR genes. GHR was highly expressed in proventriculus with much lower levels of expression in other tissues such as pancreas, brain and intestine. RT-PCR was used to quantify GHR gene expression relative to 18S rRNA in 3 wk-old male BC. GHR expression in proventriculus increased in response to fasting but did not decline with subsequent refeeding. Plasma GHR, determined by RIA, did not change significantly in response to fasting or refeeding and did not reflect changes in proventriculus GHR gene expression. GHR expression declined in pancreas after a 48 hr fast and increased upon refeeding. Expression of the gene encoding the receptor for GHR (GH secretagogue receptor, GHS-R) was detected in pancreas possibly suggesting autocrine/paracrine effects. These results offer new insights into the avian GHR gene and the potential role of GHR in regulating feed intake and energy balance in poultry.

Key Words: Ghrelin, Gene Expression, Feed Intake

T113 The effect of dosimetric levels of dietary L-carnitine on semen traits of White Leghorns. Wei Zhai^{*1}, S. L. Neuman², C. D. McDaniel³, M. A. Latour¹, and P. Y. Hester¹, ¹Purdue University, West Lafayette, IN, ²Astra Zeneca, Raleigh, NC, ³Mississippi State University, Mississippi State.

Feeding 500 ppm of dietary L-carnitine to young and aging White Leghorns for 5 wk improved sperm concentration and reduced sperm lipid peroxidation during the last half of supplementation (Neuman et al., 2002, Poultry Sci. 81:495). The current study examined the effect of feeding dosimetric levels of L-carnitine on semen traits of White Leghorns. An 8-wk trial was conducted with 48 White Leghorn roosters, 46 to 54 wk of age. Feed was formulated to contain to 0, 125, 250, and 500 mg of carnitine/kg of feed, but analyzed values were higher (3, 167, 357, and 674, respectively). Diets were fed ad libitum to 12 birds/treatment with the semen of two roosters pooled per rep per treatment to form 6 experimental units per treatment. Data were analyzed using ANOVA with repeated measurements using the mixed model procedure of SAS. Dietary carnitine did not affect feed consumption, body weight, and sperm viability. Sperm concentration of roosters fed 125 mg/kg of carnitine was significantly higher than the controls ($P < 0.05$). Dietary carnitine effects on semen volume varied over time (dietary treatment age interaction, $P < 0.003$). Semen volume increased in roosters consuming 125 mg/kg at 6 wk as compared to 2 wk post treatment ($P < 0.002$). An increase in semen volume was noted in roosters consuming 500 mg/kg of carnitine at 6 ($P < 0.0002$), 7 ($P < 0.02$), and 8 ($P < 0.007$) wk when compared to 2 wk post-treatment. Circulating levels of free and total carnitine were elevated in roosters consuming 500 mg of carnitine/kg of feed as compared to controls ($P < 0.04$). It is concluded that White Leghorns consuming 125 mg/kg of carnitine for 8 weeks as compared to controls showed an increase in sperm concentration without affecting sperm viability or having a deleterious effect on semen volume. Research supported by the U. S. Poultry and Egg Association & Lonza Group Ltd.

Key Words: L-carnitine, Semen Traits, Sperm Concentration

T114 Time course of thyroid hormone replacement and lipogenic enzyme gene expression in broilers. R. W. Rosebrough^{*}, B. A. Russell, S. M. Poch, and M. P. Richards, *Growth Biology Laboratory, ARS, USDA, Beltsville, MD.*

The purpose of this experiment was to determine the possible relationship between certain indices of lipid metabolism and specific gene expression in chickens fed methimazole to produce a kind of artificial hypothyroidism. Male, broiler chickens growing from 7 to 28 days of age were fed diets containing 18% crude protein and either 0 or 1 g methimazole per kg of diet. At 28 days, these two groups were further subdivided into groups receiving 18% crude protein diets containing either 0 or 1 mg triiodothyronine (T3) per kg. Birds were sampled at 28, 30 and 33 days. Measurements taken included in vitro lipogenesis (IVL), malic enzyme (ME) activity, the expression of the genes for ME, fatty acid synthase (FAS) and acetyl coenzyme carboxylase (ACC). Hypothyroidism decreased IVL and ME at 28 d of age; however, T3 supplementation for 2 d restored both IVL and ME. Paradoxically, continuing T3 replenishment for an additional 3d decreased IVL without affecting ME activity. In contrast, supplemental T3 decreased IVL in euthyroid birds, regardless of the dosing interval, but had no effect on ME activity. Methimazole decreased plasma T3, T4, and uric acid. Although methimazole decreased ME gene expression, there was only a transitory relationship between enzyme activity and gene expression when plasma T3 was replenished with exogenous T3. These data may help to explain some of the apparent reported dichotomies in lipid metabolism elicited by changes in the thyroid state of animals. In addition, most metabolic changes in response to feeding T3 occurred within 2 to 5 d, suggesting that changes in intermediary metabolism preceded morphological changes. In conclusion, the thyroid state of the animal will determine responses to exogenous T3.

Key Words: Lipogenesis, Thyroid, Gene

T115 Evaluation of oils and polyethylene glycol as vehicles in a nine-day chick embryo xenobiotic assay. M. E. Persia*, T. Carro, and W. W. Saylor, *University of Delaware, Newark.*

The goal of this research was to evaluate procedures and vehicles that could be used in a xenobiotic metabolism assay utilizing an embryonating egg model. In four experiments, fertile Single-Comb White Leghorn eggs were incubated for 6 d and then injected with various oils or polyethylene glycol (PEG) to determine their effects on egg, embryo and shell weight and embryo mortality. Each treatment consisted of 10 replicate eggs sampled and analyzed on d 15. In Experiment 1, 500 μ l of corn, soybean, sesame and mineral oil were compared to control eggs that did not receive injections. None of the oil treatments significantly affected egg, embryo or shell weight or embryo mortality. Autoclaved samples of corn and soybean oil were compared with non-autoclaved oil samples and controls in Experiment 2. No significant differences in weight or mortality were noted among the autoclaved, non-autoclaved and control eggs. In Experiment 3, PEG was injected into eggs at levels of 0, 250, 500, 750 and 1000 μ l. Embryos in all eggs that received 1000 μ l of PEG died by 9 d post injection. A linear increase in embryo mortality was seen with increasing PEG injection. Injection of eggs with 500 μ l of PEG resulted in 50% survivability and will be utilized in subsequent experiments. Soybean oil and PEG were both tested at 500 μ l in Experiment 4. Soybean oil did not differ from control values for any weight or embryo mortality, but 500 μ l of PEG significantly reduced embryo weight and increased mortality (50%). The results of these experiments indicate that injecting fertile eggs with corn, soybean, sesame and mineral oils resulted in similar egg, embryo and shell weights and embryo mortality as control eggs, but PEG reduced embryo weight and increases mortality. Autoclaving oil samples did not alter egg, embryo or shell weight or affect mortality.

Key Words: Xenobiotic Metabolism, Embryo Model, Vehicles

T116 Bone density measurements in broiler chickens. A. Mitchell*¹ and R. Angel², ¹USDA-ARS, ²University of Maryland, College Park.

The bone status of chickens can be measured by numerous techniques, providing a variety of parameters for evaluation. By the use of dual energy X-ray absorptiometry (DXA) it is possible to measure bone mineral content (BMC, g) and bone mineral density (BMD, g/cm²) either in vivo or on excised bones. The purpose of this study was to evaluate the relationships between DXA measured BMC and BMD in broiler chickens in vivo and in the excised bones. In two separate studies, a total of 2244 broiler birds of diverse nutritional background were scanned by DXA. In one study consisting of 1542 birds (1922 to 4091 g body weight, BWT) DXA scans were analyzed for total body and in vivo tibia BMC and BMD. In a second study of 702 birds (470 to 4110 g BWT) DXA scans were analyzed for total body BMC and BMD, and the excised tibia and femur were scanned separately and analyzed for BMC and BMD. Linear regression analysis was used to compare total body to bone measurements. For tibiae analyzed in vivo, the correlation (R²) between tibia BMC and total body BMC was 0.52 and the R² for BMD was 0.29. For excised bones, the R² with total body BMC was 0.65 for the tibiae and 0.56 for the femur, and the R² with total body BMD was 0.21 for the tibiae and 0.17 for the femur. The correlation between femur and tibia BMD was 0.58. Polynomial regression analysis was used to compare relationships among total body BWT, BMD and BMC. Combining the results of both studies, for the relationship between BWT and BMC the R² was 0.66, for BWT and BMD the R² was 0.13, and for BMC and BMD the R² was 0.58. In conclusion, the results of these studies indicate that in vivo and in vitro measurements of tibia BMC and BMD correlate similarly with total body measurements of BMC and BMD. In general, measurements of BMD, in the total body or in the individual bone showed low correlation with other parameters.

Key Words: Bone Mineral, Chickens, DXA

T117 Differentiation of chicken adipocytes in vitro. R. M. Morales*¹, M. S. Mayes², T. W. Huiatt², and C. G. Scanes^{1,2}, ¹Program in Toxicology, Iowa State University, Ames, ²Department of Animal Science, Iowa State University, Ames.

Control of excess amounts of adipose tissue are important to the animal industry. It is well established that the differentiation of mammalian

adipocyte is modulated hormonally. There is, however, little information on the hormonal control of differentiation of the chicken adipocyte. The present study examined the conditions necessary for differentiation of chicken preadipocytes in cell culture and, hence, the hormonal control of differentiation. Computer-assisted image analysis was used to analyze size of adipocytes and adipocyte clusters and the amount of lipid accumulation. Chicken preadipocytes cultured in serum free media for 3 and 5 days failed to show complete differentiation (e.g. clusters of at least five cells with abundant lipid droplets as stained with oil red O). Complete differentiation was allowed in the medium containing a combination of 1ug/ml insulin, 25ug/ml transferrin, 25ng/ml sodium selenite (ITS). The presence of triolein in the ITS media increased lipid accumulation as indicated by increased cell cross-sectional area of lipid droplets. The cocktail ITS also increased the size of clusters with <5 cells. A model to examine differentiation of chicken preadipocytes has been developed. The present data support the fundamental control of the differentiation of avian preadipocytes being similar to that in mammals.

Key Words: Chicken, Adipocyte, ITS

T118 Enhancing enterocyte enzymatic function by prebiotic feed supplementation. V. Davila¹, A. Diaz², A. Lopez-Mungia³, M. P. Castaneda¹, and G. M. Nava*^{1,4}, ¹CEIEPA, FMVZ-UNAM, Mexico City, Mexico, ²Departamento de Nutricion Animal, FMVZ-UNAM, Mexico City, Mexico, ³Instituto De Biotecnologia-UNAM, Mexico, ⁴University of Arkansas, Fayetteville.

Manipulation of the intestinal microflora with prebiotic products may affect the enterocyte physiology given that the intestinal mucosa maturation depends on beneficial bacterial colonization in neonatal animals. The objective of the present study was to evaluate the effect of inulin prebiotic administration on enterocyte enzymatic activity (maltase and sucrose) in the intestinal tract of neonatal broiler chickens. Arbor Acres chicks (1-day of hatch) were fed during 15 days with a standard diet (SD) or a standard diet supplemented with 0.2% of inulin prebiotic (SDI). At day 7 of age, intestinal samples (n=5) were taken and processed. Briefly, samples of duodenum and ileum were collected and intestinal mucosa was scraped in order to collect the enterocytes. Enterocyte homogenates (EH) were physically removed and brush border membrane vesicles (BBMV) were isolated. Enzymatic activity assays were performed using the EH and BBMV. Additionally, values of nucleotidase were analyzed. Inulin diet supplementation significantly (p<0.05) increased the concentration of intestinal maltase in the BBMV isolated from ileum at 7 days of age when compared to control diet (SD, 0.445 \pm 0.04 and SDI, 0.608 \pm 0.02 μ g of disaccharide metabolized/mg of protein/minute). Additionally, inulin supplementation during 14 days significantly (p<0.05) increased the concentration of intestinal sucrose in the BBMV isolated from duodenum when compared to control diet (SD, 0.555 \pm 0.053 and SDI, 0.816 \pm 0.027 μ g of disaccharide metabolized/mg of protein/minute). The low concentration of nucleotidase observed during this assay indicates that BBMV were isolated properly. Prebiotics stimulate the establishment of beneficial bacterial populations in the intestinal tract. It is possible that the early development of beneficial communities enhance the development of intestinal functions. The data from the present study support this hypothesis given that inulin prebiotic supplementation enhanced intestinal enzymatic activity in the BBMV section of the enterocyte.

Key Words: Prebiotic, Enterocyte, Inulin

T119 Developmental changes of plasma insulin, glucagon, IGF-I, IGF-II, thyroid hormones, and glucose concentration in chick embryo. J. Lu*¹, J. P. McMurtry², and C. N. Coon¹, ¹University of Arkansas, Fayetteville, ²USDA-ARS Growth Biology Laboratory, USDA-ARS, Beltsville, MD.

Hatching eggs from a flock of Cobb 500 females were collected and incubated. Plasma samples were obtained daily from day 10 of embryogenesis (10E) through hatch. The developmental changes of plasma insulin, glucagon, insulin-like growth factor-I and -II (IGF-I, IGF-II), triiodothyronine (T3), thyroxine (T4), and glucose concentration were investigated at different ages of the chick embryos. A significant increase in plasma insulin levels was observed from 130pg/ml at 10E to 389pg/ml at 16E. The insulin levels showed two peaks during embryogenesis (460pg/ml at 17E; 488pg/ml at hatch). Plasma glucagon levels increased from 59pg/ml at 10E to 428pg/ml at hatch; however, there was a decrease

from 12E to 19E with the lowest level of 60pg/ml at 15E. The molar ratios of insulin to glucagon (I/G) from 14E to 17E ranged from 1.8 to 2.2 which were significantly greater than normal I/G ratio in the post-absorptive state in avian species (1.2-1.7). The results indicate that insulin is an important promoter of chick embryo growth by anabolic drive to promote protein deposition especially during the embryonic rapid growth period. There also was a significant increase in plasma glucose from 13E to 18E suggesting glucose is an important regulator of protein anabolism in the chick embryo via suppression of amino acid oxidation. Plasma IGF-1 and IGF-II levels increased from 10E to 14E and then IGF-1 slowly decreased until hatch, while IGF-II remained constant. IGF-II levels were about 10 fold greater than IGF-1 suggesting IGF-II is an important functionary for chick embryonic development. Plasma T3 and T4 levels showed a significant increase during the third week of incubation and reached a peak at 19-20 E. The findings are consistent with previous research showing a sharp rise in T3 and T4 activities when the embryo switches to lung respiration.

Key Words: Chick Embryo, Hormones, Developmental Change

T120 Developmental changes of hepatic enzyme activities involved in methionine metabolism for chick embryo. J. Lu* and C. N. Coon, *University of Arkansas*.

Developmental changes in hepatic methionine adenosyltransferase (EC 2.5.1.6, MAT), cystathionine β -synthase (EC 4.2.1.22, CBS), cystathionase (EC 4.4.1.1, C-ase), 5-methyltetrahydrofolate-homocysteine S-methyltransferase (EC.2.1.1.13, MFM) and glycine

N-methyltransferase (E.C.2.1.1.20, GNMT) were determined in 11, 14, 17 and 19 day-old chick embryos and hatched chicks. Enzyme activities were expressed as nmole of product formed /min/mg of protein. The methionine-activating enzyme (MAT) activity was present at low level at day 11 of incubation but increased 8-fold to a maximum at day 19 and remained 6-fold at hatch. The MAT enzyme developmental pattern resembles the pattern observed in the rat fetus suggesting additional SAM (S-adenosyl-Methionine, sole product of MAT enzyme) is needed for rapid growth in the development of the chick embryo. Hepatic CBS activities did not change much during embryogenesis except the activity decreased to a low at day 19. High levels of hepatic C-ase were detected from day 11 through hatch. The developmental pattern of C-ase resembles the pattern observed in the rat fetus, although C-ase activity is absent from human fetal liver. Cystine can not be produced in pre-mature human infants but chick embryos do not have this limitation. Hepatic MFMT activity was higher during embryogenesis than that at hatch suggesting remethylation of homocysteine through MFMT may be a priority for the chick embryo. Previous studies indicate MFMT activity in rat liver decreases with age. MFMT is one of two methionine-conserving enzymes in broilers and layers. Chick embryos have a higher GNMT activity at day 14 than that at day 17, 19 and hatch suggesting the enzyme is more important for regulating the intrahepatic ratio of SAM to SAH (S-adenosyl-homocystine) during the middle of the incubation period. GNMT is considered the main enzyme for maintaining methyl group availability for more than 200 methylation reactions in mammals and birds.

Key Words: Chick Embryo, Enzyme Activities, Methionine Metabolism

Physiology and Endocrinology: Nutrition, Growth and Stress

T121 Effects of injecting transition cows with low doses of bovine somatotropin (bST) on milk yield, IGF-1, glucose and hepatic gene expression of gluconeogenic enzymes. M. Liboni*, M. S. Gulay, L. Badinga, M. J. Hayen, T. I. Belloso, C. J. Wilcox, and H. H. Head, *Department of Animal Sciences, University of Florida, Gainesville*.

Objectives were to evaluate effects of supplemental bST (0.4 mL, 10.2 mg/d, POSILAC[®]) during the prepartum and/or early postpartum periods on milk yield (MY), plasma concentrations of IGF-1 and glucose, and on steady state mRNA concentrations of hepatic gluconeogenic enzymes pyruvate carboxylase (PC) and phosphoenolpyruvate carboxylase (PEPCK). Multiparous Holstein cows were assigned randomly to a 2x2 factorial arrangement of treatments (TRT) to give four groups (I=no bST, n=26; II=bST postpartum, n=25; III=bST prepartum, n=27; IV=bST prepartum and postpartum, n=25). Biweekly injections of bST were in left or right ischiofemoral fossa beginning -21 d from expected calving through 70 DIM. Blood samples were collected from all cows thrice weekly throughout experiment, and liver biopsies were taken from 9 cows per TRT at -21, +2, +14 and +28 d from calving. Supplemental bST increased daily MY in all bST groups through 28 DIM (P<0.019) compared to TRT I; increases were 13.9, 12.7, and 26.6% for TRT II, III and IV, respectively. From 28 through 70 DIM, only TRT IV cows had greater daily milk yield than controls (18.7%, P<0.019). For IGF-1, significant increases were detected only during the postpartum period for cows on TRT II and IV (0-70 DIM, P<0.045); TRT group means were 107.0, 120.0, 102.8, and 132.6 ng/mL, respectively. No differences were detected in glucose concentrations (P=0.52). Hepatic levels of PC mRNA did not differ among TRT (P=0.47); PEPCK mRNA differed (P<0.01); mean levels were 165.9, 168.2, 162.7 and 161.2 arbitrary units, respectively. Results indicated that supplemental bST caused increased MY and postpartum plasma IGF-1 concentrations, but did not affect plasma glucose, or hepatic PC mRNA. Despite a small, but significant down-regulation of PEPCK mRNA for cows in TRT III and IV, these cows produced more milk than controls, and maintained similar plasma glucose concentrations.

Key Words: bST, Transition Period, Liver Gluconeogenesis

T122 Effect of insulin and growth hormone administration to mature miniature Brahman cattle on circulating concentrations of metabolic hormones and metabolites. C. C. Chase, Jr.*¹, D. G. Riley¹, T. H. Elsasser², L. J. Spicer³, M. C. Lucy⁴, S. W. Coleman¹, and T. A. Olson⁵, ¹USDA, ARS, Brooksville, FL, ²USDA, ARS, Beltsville, MD, ³Oklahoma State University, Stillwater, ⁴University of Missouri, Columbia, ⁵University of Florida, Gainesville.

The objective of this study was to determine the effect of administration of GH, insulin (INS), and GH plus INS to mature miniature Brahman cows (n = 6; 9.7 \pm 2.06 yr; 391 \pm 48.6 kg) and bulls (n = 8; 9.4 \pm 2.00 yr; 441 \pm 54.0 kg) on plasma concentrations of metabolic hormones (GH, INS, IGF-I) and metabolites (glucose, urea nitrogen [PUN]). We hypothesized that IGF-I secretion could be enhanced by concomitant administration of exogenous GH and INS, but not by either hormone alone. Animals were allotted to a modified crossover design that included four treatments: control (CON), GH, insulin (INS), and GH+INS. At the start of the study, one-half of the animals were administered GH (POSILAC; 14-d slow release) and the other one-half served as controls (CON) for 7 d. Beginning on day 8 and for 7 d, insulin (Novolin L) was administered (0.125 IU/kg BW) twice daily (0700 and 1900) to all animals; hence the INS and GH+INS treatments. Animals were rested for 14 d and then were switched to the other treatment combination. Blood samples were collected at 12-h intervals during the study. Sex affected (P < 0.05) plasma concentrations of metabolic hormones but not (P > 0.15) blood metabolites. Compared to CON, GH treatment increased (P < 0.01) mean plasma concentrations of GH (11.1 vs 15.7 \pm 0.94 ng/mL), INS (0.48 vs 1.00 \pm 0.081 ng/mL), IGF-I (191.3 vs 319.3 \pm 29.59 ng/mL), and glucose (73.9 vs 83.4 \pm 2.12 mg/dL), but decreased (P < 0.05) PUN (14.2 vs 11.5 \pm 0.75 mg/dL). Compared to INS, GH+INS treatment increased (P < 0.05) mean plasma concentrations of INS (0.71 vs 0.96 \pm 0.081 ng/mL), IGF-I (228.7 vs 392.3 \pm 29.74 ng/mL) and glucose (48.1 vs 66.70 \pm 2.12 mg/dL), decreased (P < 0.01) PUN (13.6 vs 10.4 \pm 0.76 mg/dL), and did not affect GH (13.5 vs 12.7 \pm 0.95 ng/mL). In the miniature Brahman model, using mature animals, both GH and GH+INS treatments dramatically increased circulating concentrations of IGF-I.

Key Words: Miniature Cattle, GH, IGF-I

T123 Influence of low doses of bovine somatotropin (bST) on plasma NEFA, and β -Hydroxybutyrate, hepatic lipid metabolism and gene expression of Holstein transition cows. M. Liboni*, M. J. Hayen, M. S. Gulay, L. Badinga, T. I. Belloso, and H. H. Head, *Department of Animal Sciences, University of Florida, Gainesville.*

Multiparous Holstein transition cows (n=103) were assigned randomly to a 2x2 arrangement of treatments (TRT) based upon biweekly injections of bST (0.4 mL, 10.2 mg/d, POSILAC[®]), which began 21 d before expected calving and continued through 70 DIM. The TRT were I=no bST, n=26; II=bST postpartum, n=25; III=bST prepartum, n=27; IV=bST prepartum and postpartum, n=25. During the transition period (-21 d through 28 DIM), blood samples were collected thrice weekly from all cows for quantification of non-esterified fatty acids (NEFA) and β -hydroxybutyrate (β -HBA) concentrations in plasma. Liver biopsies (9 cows per TRT) were conducted on d -21, +2, +14 and +28 from calving for the determination of total fat (FAT) and triglyceride (TG) accumulation, and the steady state expression of microsomal triglyceride transfer protein I (MTP-I) mRNA. No TRT effects were detected on NEFA (p=0.91); means ranged from 794.3 to 840.1 μ eq/L. For β -HBA, a trend for TRT effect was detected, but only during the postpartum period (P<0.07); means were 8.3, 12.6, 10.7 and 8.3 mg/dL, respectively. No TRT effects were detected on liver FAT (p=0.45) or TG (p=0.39). However, liver fat content of TRT II cows was greater than for cows on TRT II and IV (P<0.042), and also, TRT II cows had greater TG concentrations (P<0.038) than TRT I, III and IV cows on d 28; FAT and TG means were 8.45, 13.04, 8.04 and 8.31%; 1.89, 4.49, 2.32 and 1.90%, respectively. For MTP-I, significant TRT effects were detected (P<0.045); mean values were 178.6, 179.1, 174.2, 171.4 arbitrary units. As for FAT and TG, on d 28, TRT II cows had greater expression of MTP-I than TRT III (P<0.089) and IV (P<0.01) cows. In conclusion, when bST was injected only during the postpartum period (TRT II), β -HBA was increased. Despite the small but significant up-regulation of MTP-I of TRT II cows, FAT clearance from the liver was not greater than for cows on TRT I, III and IV after calving.

Key Words: bST, Transition Period, Liver Lipids

T124 Muscle and liver IGF-I mRNA expression and plasma IGF-I levels in channel catfish administered rbGH over time. B. Peterson*, G. Waldbieser, and L. Bilodeau, *USDA/ARS Catfish Genetics Research Unit Thad Cochran National Warmwater Aquaculture Center, Stoneville, MS.*

We have reported previously increased growth rates of 48% in as little as 6 wk in channel catfish administered recombinant bovine growth hormone (rbGH). Identifying genes involved in regulating growth may prove important to selecting fish for efficient lean growth. Research was conducted to examine plasma IGF-I and IGF-I mRNA expression in the muscle and liver of catfish administered rbGH. Ninety-six fish (41.1 \pm 1.5 g) were assigned randomly to one of two treatments with four replicates each. The treatments were: 1) Sham-injected control (needle puncture/week) and 2) rbGH (30 μ g/g BW/week, Posilac). Eight fish per treatment (2 fish/tank) were sampled on d 0, 1, 2, 7, 14, and 21. The fish were bled and muscle and liver samples were excised on each of the 6 sampling d. Relative expression of IGF-I mRNA was determined by real time RT-PCR. Circulating levels of IGF-I increased (55.5 \pm 2.5 ng/ml vs 22.2 \pm 1.7 ng/ml; P = 0.03) in rbGH-injected fish compared to sham-injected controls only at d 14. Expression of muscle IGF-I mRNA was not different in rbGH-injected fish compared to controls throughout the 21-d study. Liver IGF-I mRNA was increased 6-fold by d 1 in rbGH-injected fish compared to controls (P = 0.05). However, expression of liver IGF-I mRNA was not different from controls on d 2, 7, 14, and 21. Results of this study show that the growth promoting effects of rbGH were not mediated by the expression of IGF-I in the muscle. Instead, the results suggest that rbGH promotes growth by stimulating plasma IGF-I release, probably through its direct effect on the liver to synthesize IGF-I. The changes in expression and protein levels of IGF-I support IGF-I's role in growth regulation of channel catfish.

Key Words: IGF-I, Real Time PCR, Channel Catfish

T125 Cloning, expression and functional analysis of the porcine prolactin receptor. J. F. Trott, N. R. Farley, and R. C. Hovey*, *University of Vermont, Burlington.*

Prolactin (PRL) is an important reproductive hormone in pigs that functions through the prolactin receptor (PRLR) protein that is present in tissues such as the mammary gland, ovary and uterus. PRL may be of particular significance for reproduction in pigs due to their lack of placental lactogens that can bind the PRLR. Our objective was to clone the full length pPRLR cDNA and study its function. Using 5' RACE we have cloned the full-length pPRLR that encodes a mature protein of 601 amino acids. As anticipated, the pPRLR transduced a differentiation signal to the β -casein milk protein gene promoter *in vitro* following PRL treatment. Analysis of different ligands in this assay revealed that human growth hormone (hGH) and pPRL effected a greater transcriptional response (P#8804.0005) compared to oPRL. Transfection of CHO-K1 cells with the pPRLR revealed binding of hGH at high affinity (Kd=1.75 nM), similar to characteristics for the hPRLR (Kd=3.6 nM). The pPRLR also displayed higher affinity (P#8804.01) for pPRL compared to oPRL. Under normalized transfection conditions, the number of active receptor sites per cell was higher for the pPRLR than the hPRLR (P#8804.001), consistent with results from western blotting experiments. While both the pPRLR and hPRLR showed perinuclear intracellular distribution in transfected CHO cells as determined by immunocytochemistry, the pPRLR primarily localized to the cytoplasm whereas the hPRLR was more concentrated in vesicles (P#8804.05). Expression of pPRLR mRNA in miniature pig tissues as determined by quantitative RT-PCR was lowest in the ovary and highest in the mammary gland (P#8804.05). Our data indicate that the pPRLR demonstrates several unique characteristics at the post-transcriptional, post-translational and functional level.

Key Words: Prolactin, Pig, Prolactin Receptor

T126 Fluctuation of plasma ghrelin and growth hormone in fed and fasted cattle. A. E. Wertz*¹, T. J. Knight², A. Kreuder², M. Bohan², D.C. Beitz², and A. Trenkle², ¹South Dakota State University, Brookings, ²Iowa State University, Ames.

Four steers (450 \pm 28.5 kg) were used in a crossover design to determine fluctuation of plasma ghrelin and growth hormone (GH) concentrations in fed and fasted beef cattle. Cattle were adapted to a once daily feeding schedule over an 11-d period. Feed, sufficient to result in 10% weight-back, was offered at 0800 h and removed at 2000 h. After adaptation, two steers continued the once daily feeding schedule (FED) whereas; feed was withheld from the other two steers (FAST). Steers were fitted with indwelling jugular catheters 24 h before sampling. Serial blood samples were collected at 10-min intervals from 1800 to 2000 h (22 to 24 h fasting) and from 0600 to 0800 h (34 to 36 h fasting). From 0815 to 2000 h (36 to 48 h fasting), steers were sampled at 15-min intervals. A 5-d crossover period was used between sampling periods to re-establish the once daily feeding schedule. Treatment groups then were switched, and the sampling period was repeated. Plasma ghrelin and growth hormone concentrations were quantified using radioimmunoassays. Data were analyzed statistically as repeated measures using the mixed procedure of SAS. Peak concentrations were defined as concentrations that were two standard deviations greater than the baseline using PEAK software. Average plasma ghrelin concentrations were elevated (P<0.001) in FAST (648 \pm 10.4 pg/mL) compared with FED (115 \pm 3.5 pg/mL) steers. Plasma ghrelin concentration for FED steers reached a maximum just prior to feeding and then returned to baseline post-feeding, whereas ghrelin concentrations for FAST steers did not exhibit this pattern during the time period. Episodic ghrelin peaks, however, were detected for FAST steers beyond 40 h fasting. Plasma GH peaks tended to be more frequent (P=0.06) just prior to feeding, from 0600 to 0800, for FED compared with FAST steers. In contrast, FAST steers had more frequent (P#8804.02) GH peaks beyond 40 h of fasting. Plasma ghrelin concentrations fluctuated when feed intake was restricted, and differences in ghrelin concentrations correspond to difference in GH peak frequency.

Key Words: Ghrelin, Growth Hormone, Beef Cattle

T127 Plasma hormones and expression of growth hormone receptor (GHR) 1A and IGF-I mRNA in hepatic tissue of feed-restricted peri-parturient dairy cows. R. P. Radcliff^{*1}, B. L. McCormack¹, B. A. Crooker², and M. C. Lucy¹, ¹University of Missouri, Columbia, ²University of Minnesota, St. Paul.

The primary GHR mRNA transcript in liver (GHR 1A) is decreased at parturition and then gradually increases. We hypothesized that decreased food intake after parturition inhibits normal postpartum up-regulation of GHR 1A mRNA expression. Liver was biopsied from Holstein cows (n = 11) on d 10 ± 1, 1, 7, 14 and 21 postpartum. Blood samples were collected during the biopsy period. Cows were offered feed ad libitum prepartum. After parturition, six cows were fed 70% of their expected feed intake (feed-restricted; FR) for 14 d and five cows were fed ad libitum (Control). Both groups had ad libitum feed after d 14. Total cellular RNA was isolated from liver samples and GHR 1A and IGF-I mRNA were measured using quantitative real-time polymerase chain reaction. Dry matter intake (7 vs. 11 ± 1 kg/d; *P* < 0.03), milk yield (29 vs. 34 ± 2 kg/d; *P* = 0.1), and energy balance (-18.5 ± 0.7 vs. -15.4 ± 0.8 Mcal/d; *P* < 0.02) were less for FR compared to control cows (d 1 to 14). Plasma NEFA concentrations were greater (1190 ± 105 vs. 715 ± 115 µEq/L; *P* < 0.02) and plasma glucose concentrations tended to be less (50.2 ± 3.4 vs. 59.1 ± 3.7 mg/dL; *P* = 0.1) for FR vs. control cows (d 1 to 14). Amounts of GHR 1A mRNA decreased after parturition (*P* < 0.001). A treatment by day interaction for GHR 1A was detected because GHR 1A mRNA was less for FR cows on d 21 (7 days after FR ended; 986 ± 107 vs. 421 ± 97 fg/25 ng RT; *P* < 0.001). Amounts of IGF-I mRNA and plasma IGF-I concentrations decreased after parturition. Postpartum plasma IGF-I concentrations tended to be lower (51 vs. 65 ± 5 ng/ml; *P* = 0.09) but postpartum liver IGF-I mRNA concentrations were similar for FR vs. control. Feed-restriction decreased GHR 1A mRNA. The decrease in GHR 1A mRNA was present 7 days after the end of FR. We conclude that feed intake partially controls GHR 1A mRNA expression in early postpartum dairy cows and that the effect of FR may persist for at least one week.

Key Words: Growth Hormone Receptor, Feed Intake, Parturition

T128 Effect of naloxone, an opioid antagonist, on serum calcium concentrations immediately after parturition in multiparous Holstein cows. F. Frago¹, A. Ahmadzadeh^{*1}, R. Manzo¹, M. A. McGurie¹, and J. C. Dalton², ¹University of Idaho, Moscow, ²Research and Extension Center, University of Idaho, Caldwell.

This experiment was conducted to investigate the effect of naloxone, an opioid receptor antagonist, on serum calcium (Ca) homeostasis and pH, within the first 24 hours post-partum, in Holstein cows. Prior to parturition cows received a close up ration that met the NRC requirements for dry cows. Shortly after parturition and the first milking, cows were weighed and assigned randomly to receive either saline (n = 6), or 0.01 mg/kg of BW of naloxone (n = 6). Blood samples were collected at 10-minute intervals for 20 min before and 50 min after treatments. Mean serum Ca was not different between groups before treatments (8.6 vs. 10.4 mg/dL; SEM = 1.0). Naloxone caused a transient increase (*P* < 0.05) in serum Ca concentrations within 20 min after injection (from 10.4 to 14.8 mg/dL; SEM = 1.0). Mean serum Ca was not altered in saline-treated cows. There was no change in the mean serum pH in naloxone- or saline-treated groups. These results suggest that endogenous opioid peptides (EOP) play a role in Ca homeostasis in lactating Holstein cows and its inhibitory action is mediated through opioid receptors. Therefore, EOP may play a part in milk fever.

Key Words: Opioid Antagonist, Early Postpartum, Calcium

T129 Effects of short-term fasting on channel catfish growth and nycthemeral concentrations of plasma GH, IGF-I, and cortisol. B. C. Small^{*}, USDA/ARS Catfish Genetics Research Unit, Thad Cochran National Warmwater Aquaculture Center, Stoneville, MS.

Short-term fasting is a common management tool for controlling enteric septicemia of catfish; however, little is known concerning the physiological ramifications of short-term fasting. In many animals, long-term starvation affects the somatotrophic and the corticotrophic axes, often resulting in increased plasma concentrations of growth hormone (GH) and cortisol, and decreased concentrations of circulating IGF-I. This study

was conducted in order to characterize the effect of short-term fasting on plasma concentrations of GH, IGF-I, and cortisol over a 24-h period. Channel catfish fingerlings (mean=14.8 g) were stocked into forty-eight 76-L aquaria and acclimated for two wk. A photoperiod of 12L:12D was maintained throughout the study, with lights coming on at 0600 h daily. Treatments were assigned randomly such that fish in 24 aquaria were fed twice daily to satiety and fish in the remaining aquaria were fasted. The study was conducted for 21 d. On d 21, fish in the fed treatment were fed at 0650 h. Beginning at 0700 h and continuing every 2 h for 24 h, fish from two tanks per treatment were bled and plasma collected. After 3 wk, weight of fed fish increased an average of 65.7%, while fasted fish lost 21.3% on average. Nycthemeral concentrations of plasma GH were not significantly (*P*>0.05) different between fed (24.7 ng/mL) and fasted (26.8 ng/mL) fish. Paradoxically, nycthemeral IGF-I concentrations were different (*P*<0.05) between fed (23.4 ng/mL) and fasted (17.8 ng/mL) fish, and not different for times within treatments. Nycthemeral plasma cortisol concentrations were also different (*P*<0.05) between fed (14.5 ng/mL) and fasted fish (11.0 ng/mL), and different (*P*<0.05) for times within treatments. The present study indicates little or no effect of short-term fasting on plasma GH levels, but does demonstrate fasting-induced suppression of plasma IGF-I levels, and a correlation between feeding and cortisol secretion in channel catfish.

Key Words: Channel Catfish, Fasting, Hormone Profiles

T130 Microarray analysis of gene expression in ovarian dominant follicles (DF) following heat stress (HS). S. J. Kolath^{*1}, P. M. Coussens², S. S. Sipkovsky², S. J. Wilson¹, D. E. Spiers¹, J. N. Spain¹, and M. C. Lucy¹, ¹University of Missouri, Columbia, ²Michigan State University, East Lansing.

Heat stress decreases follicular growth and causes infertility in cattle. Our objective was to compare gene expression in DF from heifers exposed to HS or thermoneutral (TN) environments. Estrous cycles were synchronized (estrus = d 0) in Holstein heifers assigned randomly to HS (n=3) or TN (n=3) treatment. On d 5, heifers were moved into the Brody Environmental Chambers (19°C). Ambient temperature for HS heifers was increased on d 10, 3°C per day to 33°C on d 14. Ambient temperature for TN heifers remained at 19°C. The second wave DF was collected after ovariectomy on d 15. Total RNA was isolated, amplified using MessageAmp aRNA Kit (Ambion Inc., Austin, TX), reverse transcribed, labeled, and hybridized to the NBFGC microarray (18,263 unique ESTs) from the Center for Animal Functional Genomics (<http://gowhite.ans.msu.edu>). Follicular cDNA was labeled with Cy5 and a reference sample cDNA (comprised of mRNA from 29 bovine tissues) was labeled with Cy3 (n=10 microarrays). Fluorescence was measured using the GenePix 4000B scanner (Axon Instruments Inc., Union City, CA) and data were analyzed using GeneSpringTM software (Silicon Genetics, Redwood City, CA). A Student's t-test was performed using a Benjamini and Hochberg False Discovery Rate. Genes whose mRNA was enriched in DF had a fluorescent signal greater (*P*<.05) than the reference sample. There were 1,354 candidate genes whose mRNA was enriched in DF; 179 of which were increased greater than two-fold above the reference. Genes with greater than two-fold up-regulation encoded cell structural components (FMOD, ACTA2, GNB2L1), were involved in cell growth (VSGP/F-spondin, SPARC) and hormone transport (SHBG), and were transcription factors (ATF1, HIF-1, TFIID). Some of the discovered genes had not been reported previously in ovary. Heat stress increased body temperature (*P*<.01) but had no effect on follicle-specific mRNA. We conclude that microarray analysis with a reference design can be used to identify novel mRNA in ovary.

Key Words: Microarray, Ovary, Heat Stress

T131 Effects of conjugated linoleic acid on culture of adipose tissue explants of growing pigs. A. A. F. B. V. José, M. A. S. Gama, and D. P. D. Lanna^{*}, LNCA-ESALQ-USP, Brazil.

The objective of this study was to evaluate the effects of conjugated linoleic acid (CLA; 94.5% of t10,c12 CLA) on lipogenesis (measured as rates of 14C labeled glucose incorporation over a subsequent 2 h incubation), lipolysis (release over a subsequent 2 h incubation of non-esterified fatty acid - NEFA), and activities of lipogenic enzymes in explants of adipose tissue collected from growing pigs. Adipose tissue explants from nine pigs (78±3 kg) were cultured in medium 199 with insulin, dexamethasone and antibiotics for 4, 12, 24 and 48 hours. Treatments were: Control: 100 µM of PVA (polyvinyl alcohol); CLA

200: 200 μ M of CLA; CLA50: 50 μ M of CLA; LA: 200 μ M of linoleic acid and pGH: 100 ng/mL (porcine growth hormone - Reporcin, Southern Cross Biotech). Free fatty acids were complexed to PVA (2:1) as a carrier. After each culture period explants were collected and assayed for lipogenesis. After 48 h in medium 199 samples were analyzed for NEFA release (Krebs-ringer buffer, for 2 h) and explants taken for measurement of fatty acid synthase (FAS), glucose 6-phosphate dehydrogenase (G6PDH), 6-phosphogluconate dehydrogenase (6PGDH) and NADP-malate dehydrogenase activities. Glucose incorporation was significantly decreased ($P < 0.05$) in response to pGH treatment. The activity of FAS was consistently decreased by pGH ($P = 0.07$). Linoleic acid had no effect on any parameter evaluated. Lipid synthesis was decreased after culture; Control = 5390 and 2333 nmoles/2h.g; and CLA200 = 4296 and 1900 nmoles/2h.g, respectively. However, the effect of CLA was not statistically significant. Despite the lack of a significant effect of CLA on lipogenesis, FAS activity was decreased in response to CLA at 200 μ M ($P < 0.05$). The NADPH generating enzymes were not affected by any of the treatments. The pGH treatment increased basal lipolysis ($P < 0.05$), but CLA treatment had no effect ($P > 0.05$) on NEFA release after 48 h of culture. These data suggest CLA decreases FAS activity in cultures of pig adipose tissue explants.

Key Words: Adipose Tissue Explants, Lipid Metabolism, Swine

T132 Somatotropic axis components following administration of exogenous bovine somatotropin to neonatal beef calves having an IGF-I promoter polymorphism. E. F. Jones*, K. E. Govoni, T. A. Hoagland, G. W. Kazmer, and S. A. Zinn, *University of Connecticut, Storrs.*

In cattle, serum concentrations of components of the somatotropic axis and its response to bovine somatotropin (bST) are age dependent. In addition, changes in serum concentrations of insulin-like growth factor (IGF)-I are associated with a polymorphism in the promoter region of IGF-I. To determine the response of components of the somatotropic axis and the association of the polymorphism with concentrations of IGF-I in neonatal calves, 44 newborn beef calves (22 males, 22 females) were utilized. Within 24 hr of birth, blood samples ($n=3$, 10 mL, 30 min apart) were collected via venipuncture of a jugular vein. Following collection of the third blood sample, half of the males and half of the females were administered bST (500 mg; d 0). Blood samples ($n=3$, 10 mL, 30 min apart) were collected from each animal on d 1, 3, 5 and 7. Concentrations of ST and IGF-1, and IGF binding protein (BP) -2 and -3 were determined by RIA and ligand blot, respectively. Calves were genotyped using single stranded conformational polymorphism techniques. Concentrations of ST, IGF-I, IGFBP-2 and IGFBP-3 averaged 14 ± 4 ng/mL, 104 ± 16 ng/mL, 20 ± 1 AU (arbitrary units) and 25 ± 2 AU, respectively. Concentrations of ST (18 ± 6 vs 94 ± 6 ng/mL) and IGF-I (114 ± 24 vs 142 ± 22) were increased ($P < 0.01$) on d 1 and 3 by bST treatment, after which increased concentrations of ST and IGF-I were maintained. Neither serum IGFBP-2 (17 ± 1 vs 17 ± 1 AU) nor IGFBP-3 (23 ± 1 vs 23 ± 1) were altered ($P > 0.10$) by bST treatment. Response to bST was greater in males than females (91 ± 7 vs 53 ± 7 ng/mL), but no gender differences ($P > 0.10$) in IGF-1 or IGFBP-2 and -3 were found. Frequencies were 24%, 52% and 24% for AA, AB and BB genotypes, respectively. Concentrations of IGF-1 in AA (179 ± 17 ng/mL), AB (201 ± 12 ng/mL) and BB (211 ± 17 ng/mL) calves were not different ($P > 0.37$). As early as 1 d of age IGF-I concentrations in calves increased in response to bST, but no association between IGF-I concentrations at this age and IGF-I promoter polymorphism was found.

Key Words: Somatotropic Axis, Beef Cattle, IGF-I Polymorphism

T133 Microarray analysis of hepatic gene expression from dry-off through early lactation in dairy cows fed at two intakes during the dry period. J. J. Loor*, N. A. Janovick, H. M. Dann, R. E. Everts, S. L. Rodriguez-Zas, H. A. Lewin, and J. K. Drackley, *University of Illinois, Urbana.*

A bovine cDNA microarray was used to study gene expression during the periparturient period in response to restricted or ad libitum DMI during the dry period. Liver from four Holstein cows with ad libitum (ca. 150% of NRC requirements; AA) or restricted (80% of requirements; RR) DMI of far-off and close-up diets was biopsied at -65, -30, -14, 1, 14, 28, and 49 d relative to parturition. All cows had ad libitum access to the same lactation diet. A microarray consisting of 7,872 cDNA inserts was used for transcript profiling. Annotation was based on similarity

searches using BLASTN and TBLASTX against human and mouse UniGene databases and the human genome. Cy3- and Cy5-labelled cDNA from liver and a reference standard (derived from a mixture of cattle tissues) were used for hybridizations (106 microarrays). Loess-normalized log-transformed ratios (liver/standard) were used to detect differential gene expression. Using Benjamini and Hochberg's False Discovery Rate ($P = 0.10$) to determine effects of prepartum DMI, day, or their interaction on differential gene expression resulted in 2,537, or 29 significant genes, respectively. Among those with significant interactions were genes associated with lipid metabolism, signal transduction, and insulin action. Genes differentially expressed by day relative to parturition included some involved in cell proliferation, carbohydrate metabolism, and protein catabolism. Hierarchical clustering showed that expression patterns on d -14, 1, and 14 were grouped in two clusters according to prepartum DMI. RR resulted in greater number of genes being upregulated 1.5 fold or greater ($P = 0.05$) on d 1 vs. d -14 (AA, 21; RR, 286). A similar trend was observed when comparing d 14 (AA, 31; RR, 139), d 28 (AA, 334; RR, 910), and d 49 (AA, 398; RR, 1,036) vs. d 1. Our data indicate that prepartum plane of nutrition alters hepatic gene expression during the peripartum period. (Supported by award 2001-35206-10946 from NRI Competitive Grants Program/CSREES/USDA).

Key Words: Liver, Microarray, Gene Expression

T134 Mammary and hepatic gene expression analysis in peripartal dairy cows using a bovine cDNA microarray. J. J. Loor*, H. M. Dann, R. E. Everts, S. L. Rodriguez-Zas, H. A. Lewin, and J. K. Drackley, *University of Illinois, Urbana.*

Simultaneous analysis of mammary and hepatic gene expression in peripartal dairy cows was studied using cDNA microarray technology. Mammary and liver tissue were collected at -14, 1, and 14 d relative to parturition from two multiparous Holstein cows fed according to current NRC recommendations. A microarray consisting of 7,872 cDNA inserts was used for transcript profiling. Annotation was based on similarity searches using BLASTN and TBLASTX against human and mouse UniGene databases and the human genome. Cy3- and Cy5-labelled cDNA from liver and a reference standard (derived from a mixture of cattle tissues) were used for hybridization (24 microarrays). Loess-normalized log-transformed ratios (tissue/standard) were used to detect differential gene expression. Benjamini and Hochberg's False Discovery Rate ($P = 0.05$) and a global gene error model, to account for the dependence of variation on signal intensities, were used to determine differential gene expression for the effect of tissue (1,040), day (20), and tissue by day (392) interactions. Among genes with a significant tissue by day interaction, expression ratios greater than 5-fold in liver compared with mammary were found for 15, 12, and 13 genes on d -14, 1, and 14, respectively. Among those showing tissue-specific expression, there were 26 genes with >5-fold expression in mammary compared with liver, and 44 genes with >5-fold expression in liver compared with mammary. Expression patterns in liver clustered together on d -14 and 14, and in mammary on d 1 and 14. Differences in expression patterns within these clusters ranged from 11% (liver) to 30% (mammary). Results show the power of microarrays to dissect gene expression patterns in tissues during the peripartum period. (Supported by award 2001-35206-10946 from NRI Competitive Grants Program/CSREES/USDA).

Key Words: Liver, Mammary, Microarray

T135 Adipose, mammary, and hepatic gene expression profiling in lactating dairy cows using a bovine cDNA microarray. J. J. Loor*, N. A. Janovick, R. E. Everts, S. L. Rodriguez-Zas, H. A. Lewin, and J. K. Drackley, *University of Illinois, Urbana.*

Simultaneous analysis of gene expression in four adipose depots [mesenteric (MS), omental (OM), subcutaneous (SQ), perirenal (PR)], mammary (MG), and liver (LV) of lactating cows was performed using cDNA microarray technology. Tissues were collected at slaughter from multiparous cows around peak (50 DIM), mid (95 DIM), and late (245 DIM) lactation. A microarray consisting of 7,872 cDNA inserts was used for transcript profiling. Annotation was based on similarity searches using BLASTN and TBLASTX against human and mouse UniGene databases and the human genome. Cy3- and Cy5-labelled cDNA from liver and a standard reference (derived from a mixture of cattle tissues) were

used for hybridizations. Loess-normalized log-transformed ratios (tissue/standard) were used to detect differential gene expression. Clustering analysis of gene expression around peak lactation (12 microarrays) showed that SQ had expression patterns that differed by 57% from other tissues. LV gene expression differed from MG and adipose by 50%; whereas expression in MG differed from adipose by 44%. Among adipose depots, gene expression in PR differed from MS and OM by 17%. Using Benjamini and Hochberg's False Discovery Rate ($P = 0.05$) and a global gene error model, to account for the dependence of variation on signal intensities, we detected differential expression of 355 genes across tissues. The same 24 genes were >5-fold ($P = 0.05$) in SQ than LV or MG. Some of these genes were associated with intracellular signaling, inflammatory responses, and apoptosis. One gene involved in the regulation of glucose oxidation was 3-, 5-, and 20-fold greater ($P = 0.05$) in MS, OM, and PR, respectively, than SQ. Thirteen genes were >5-fold in LV than MG, and 10 were >5-fold ($P = 0.05$) in MG than LV. Genes with >5-fold ($P = 0.05$) expression in LV than other tissues included one of the mitochondrial lipid oxidation pathway and one of unknown function. Our results reveal previously unknown tissue-specific gene expression patterns during established lactation.

Key Words: Tissue, Gene Expression, Lactation

T136 Gene expression profiles in liver of dairy cows in response to feed restriction using a bovine cDNA microarray. J. J. Looor*, D. B. Carlson, R. E. Everts, S. L. Rodriguez-Zas, H. A. Lewin, and J. K. Drackley, *University of Illinois, Urbana.*

Dairy cows decrease DMI around parturition but little is known about associated changes in tissue gene expression. We studied the effects of acute feed restriction on hepatic gene expression using cDNA microarray technology. During a 14-d period, six Holstein cows in mid-lactation (132 ± 38 DIM) had ad libitum access to a TMR (NR) or were restricted to 50% of previous 5-d DMI (FR) from d 10 through 14. Liver was biopsied on d 14. A microarray consisting of 7,872 cDNA inserts was used for transcript profiling. Annotation was based on similarity searches using BLASTN and TBLASTX against human and mouse UniGene databases and the human genome. Cy3- and Cy5-labelled cDNA from liver and a reference standard (derived from a mixture of cattle tissues) were used for hybridizations (24 microarrays). Loess-normalized log-transformed ratios (liver/standard) were used to detect differential gene expression. Ninety-nine differentially expressed genes were found using Benjamini and Hochberg's False Discovery Rate ($P = 0.10$) and a global gene error model (to account for the dependence of variation on signal intensities). Forty-six were 0.9- to 0.5-fold lower and 53 were 1- to 5-fold greater with FR. Genes associated with intracellular acyl-CoA ester transport, stress responses, and the tricarboxylic acid cycle were among those downregulated by FR. In contrast, FR increased hepatic expression of genes with links to immune responses, antioxidant activities, signal transduction, and apoptosis. Our results demonstrate that hepatic gene expression is altered in response to plane of nutrition. (Supported by award 2001-35206-10946 from NRI Competitive Grants Program/CSREES/USDA).

Key Words: Feed Restriction, Liver, Microarray

T137 Accuracy and precision of commercially available glucometers for use in dairy cattle. C. C. Williams*, A. M. Ponson, C. C. Stanley, H. G. Bateman, II, P. T. Richardel, and D. T. Gantt, *LSU AgCenter, Baton Rouge, LA.*

An experiment was conducted to validate two commercially available glucometers for use in dairy cattle. Six female Holstein calves approximately one mo of age, six Holstein steers approximately 4 mo of age, and six lactating Holstein cows were subjected to intravenous glucose tolerance tests (IVGTT) and insulin tolerance tests (ITT). These tests induced glucose concentrations ranging from very high (IVGTT) to very low (ITT) to test the sensitivity of the glucometers. In both tests, conducted on consecutive d, animals were fitted with indwelling jugular catheters 1 h prior to testing. In the IVGTT, glucose (0.5 g/kg BW) was infused at once, while in the ITT bovine insulin (0.03 units/kg BW) was infused at once. Relative to the glucose or insulin bolus, blood samples were collected at -10, 0, 5, 15, 25, 35, 45, and 60 min. Blood glucose concentrations were immediately measured in duplicate using the Accu-Chek® Glucometer (Roche, Inc.) and the Glucometer Elite® (Bayer Corp.). At each time point a blood sample was collected and plasma was frozen for glucose analysis using commercial spectrophotometric kits. Correlation coefficients were calculated to determine the

degree of linear association between glucometer readings and plasma glucose concentrations. Both glucometers were strongly correlated with plasma glucose concentrations in calves ($r = 0.975$ and 0.979), steers ($r = 0.992$ and 0.989), and cows ($r = 0.993$ and 0.996) for Accu-Chek® and Elite®, respectively. Glucometers were strongly correlated with plasma glucose in the IVGTT ($r = 0.980$ and 0.985 for Accu-Chek® and Elite®, respectively). However, in the ITT the correlations decreased ($r = 0.873$ and 0.754 for Accu-Chek® and Elite®, respectively) as plasma glucose concentrations were reduced. Coefficients of variation were 3.60% and 3.51% for the Accu-Chek® and Elite®, respectively, in the IVGTT, and 1.85% and 1.79% for the Accu-Chek® and Elite®, respectively, in the ITT. These data indicate that commercially available glucometers are valid for measuring blood glucose concentrations in dairy cattle.

Key Words: Glucometers, Blood Glucose, Dairy Cattle

T138 Effects of bovine somatotropin (bST), pregnancy and a diet enriched in omega-3 fatty acids on the uterine GH/IGF system in lactating dairy cows. T. R. Bilby*¹, F. Michel¹, T. Jenkins², C. R. Staples¹, and W. W. Thatcher¹, ¹University of Florida, Gainesville, ²Clemson University, Clemson, SC.

The objective was to examine the effects of bST, pregnancy and dietary fatty acids on the GH/IGF system in lactating dairy cows. Two diets were fed, starting 18 days postpartum (PP), in which the oil of whole cottonseed (15% of dietary DM; control diet; n=19) was compared to calcium salts of fatty acids containing fish oil (FO), high in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA; 1.9% of dietary DM; n=8). All cows started an Ovsynch protocol between d 5 and 12 of an estrous cycle and were assigned randomly to be time inseminated (d 0; ~ 77 d PP) or not, and to receive either a bST (500 mg) injection on d 0 and 11 d later or not. On d 17, cows were slaughtered and uterine luminal flushings (ULF), endometriums and conceptuses were recovered. The number of cows in each group was as follows: control diet had 5 bST-treated cyclic (bST-C), 5 non bST-treated cyclic (C), 4 bST-treated pregnant (bST-P), and 5 non bST-treated pregnant (P) cows; FO diet had 4 bST-treated (bST-CFO) and 5 non bST-treated cyclic (CFO) cows. GH receptor mRNA was undetectable in the endometrium of all cows. Endometrial IGF-I mRNA was reduced in pregnant cows ($P \# 88040.01$) and tended to decrease in FO fed (+/- bST) versus C (+/- bST) cows ($P \# 88040.06$). IGF-II mRNA was increased in the endometrium of P and bST treated cows on the control diet ($P \# 88040.01$). Cows fed FO had increased concentrations of IGF-II mRNA, regardless of bST treatment ($P \# 88040.05$). IGFBP-2 mRNA was increased in bST-P cows ($P \# 88040.05$), whereas bST decreased the IGFBP-2 mRNA in all cyclic cows ($P \# 88040.05$). Treatments did not differ in endometrial IGFBP-3 mRNA or for ULF content of IGFBP-3, IGFBP-4, GH and IGF-I. EPA and DHA were increased in the endometrium and liver ($P \# 88040.01$), and DHA was increased in the milk of FO fed cows vs. control cyclic cows ($P \# 88040.01$). In conclusion, bST, pregnancy, and FO can have differential effects on the GH/IGF system.

Key Words: Pregnancy, Somatotropin, Fish Oil

T139 Unique effects of ovarian steroid hormones on parenchymal morphology in the mammary glands of swine. J. M. Scudder*, A. S. Barndollar, J. F. Trott, and R. C. Hovey, *University of Vermont, Burlington.*

Sufficient milk production by sows is a major limitation for piglet growth. The main structural component in the mammary glands of gilts is a lobular structure referred to as the terminal duct lobular unit (TDLU) that arises from mammary ducts. These can be classified as a TDLU-1, -2, or -3, depending on the number of ductules present. Separately, end buds (club-like structures) are also present in the mammary gland to direct ductal elongation. We hypothesized that the proportion of different structures in the mammary glands of gilts is regulated by ovarian steroid hormones. Ovary intact, sexually-mature Yucatan miniature swine were treated with estrogen (E2), progesterone (P4), or saline for 5 days. Mammary gland tissues were prepared as semi-thick sections and mounted on slides before staining to identify the various structures. Other sections were prepared at 4µm and stained with hematoxylin and eosin. We used a histomorphometric approach to quantify the number of different structures in the mammary glands of each animal. Across treatments we found that TDLU-1, -2 and -3 structures in

the mammary glands of gilts contained an average of 11, 35 and 81 ductules, respectively. In saline treated animals, 37.4%±10%, 59.2%±8% and 3.4%±2.5% of the structures were present as TDLU-1, -2 and 3, respectively (TDLU-1 vs TDLU-2, P#8804.16; TDLU-1 vs TDLU-3, P#8804.02). These proportions were not altered by hormone treatment (P#8805.05). We did however find hormone-induced changes in the number of end buds within the mammary gland. The number of end buds per gland following treatment with saline, E2 or P4 was 4.75±2.8, 16.5±5 and .5±.5 (SAL vs E2, P#8804.03; SAL vs P4, P#8804.09). Separately, histological examination revealed increased secretory activity with E2 treatment. Taken together, our results show that ovarian steroid hormones have pronounced effects on parenchymal morphology and cell proliferation in the mammary glands of gilts that may influence a sows milk production potential.

Key Words: Mammary Gland, Morphology, Ovarian Hormones

T140 Effects of bovine somatotropin (bST), pregnancy and a diet enriched in omega-3 fatty acids on reproduction in lactating dairy cows. T. R. Bilby*¹, A. Sozzi¹, M. Lopez¹, F. Silvestre¹, A. Ealy², C. R. Staples¹, and W. W. Thatcher¹, ¹University of Florida, Gainesville, ²The Pennsylvania State University, University Park.

The objective was to examine effects of bST, pregnancy and dietary fatty acids on reproductive responses in lactating dairy cows. Two diets were fed, starting 18 d postpartum (PP), in which oil of whole cottonseed was compared to calcium salts of fatty acids containing fish oil (FO). The Ovsynch protocol was administered between d 5 and 12 of the estrous cycle, and cows were assigned randomly to be time inseminated (d 0; ~ 77 d PP) or not, and to receive a bST (500 mg) injection on d 0 and 11 or not. Daily blood samples were taken from d 0 d 17, and ovarian responses were measured by ultrasound on d 7, 9, 11, 13, and 15-17. Cows were slaughtered on d 17, and uterine luminal flushings (ULF), conceptuses and CL were recovered. Number of cows in each group was as follows: control diet had 5 bST-treated cyclic (bST-C), 5 non bST-treated cyclic (C), 4 bST-treated pregnant (bST-P), and 5 non bST-treated pregnant (P) cows; FO diet had 4 bST-treated (bST-CFO) and 5 non bST-treated cyclic (CFO) cows. The bST increased pregnancy rate (83% [5/6]>40% [4/10]; P#8804.10), conceptus length (45>34 cm; P#8804.10) and INF- τ in the ULF (9.4>5.3 μ g; P#8804.05) with no effect on INF- τ mRNA concentration in the conceptus. The CL tissue volumes tended to be higher in P cows versus C cows (P#8804.10) and was higher at slaughter (P#8804.05). Pregnancy altered (P*; P#8804.05) size of the second wave dominant follicle and number of Class 2 follicles indicative of a less active dominant follicle in P cows. Treatment with bST increased plasma GH and IGF-I (P#8804.01); among control fed cows (cyclic and pregnant) bST decreased P4 (P#8804.05). The FO (+/-bST) cows had lower plasma insulin than C cows (+/-bST; P#8804.05), and FO altered (FO*d) the GH (bST-CFO>bST-C; P#8804.01) and IGF-1 (bST-C>bST-CFO; P#8804.05) responses to bST injections. In summary, bST and FO appear to modulate reproductive responses that may be beneficial to the developing conceptus.

Key Words: Pregnancy, Somatotropin, Fish Oil

T141 Effects of ambient temperature and solar radiation on skin evaporative water loss in dairy cattle. B. C. Pollard*, M. E Dwyer, A. C. Fitzgerald, P. C. Gentry, D. A. Henderson, and R. J. Collier, *University of Arizona, Tucson.*

To determine effects of ambient temperature and solar radiation on total evaporative water loss (TEWL) in cattle, non-lactating, Holstein cows (n=6) and heifers (n=6) were randomly assigned to one of two treatments in a climate control facility and given ad libitum access to feed and water. Both treatments were provided a dry bulb temperature at 0500 h of 27.8°C and a maximum temperature of 39.4°C at 1500 h to mimic the average for Summer Solstice (SS) in Tucson, AZ. The two treatments differed by either the addition of SS levels of solar radiation (S) or high ambient temperature alone (NS). Sunrise began at 0600 h, sunset at 1950 h, with maximum irradiation (1,061 Wh/m²) at 1200 h. At two hour intervals, rectal temperature (RT), respiration rate (RR), and skin temperature (ST) were estimated by infrared reflection and TEWL were determined at five points (rump, loin, udder, rib and neck). Closed-chamber TEWL was determined with a Vapometer® (Delfin Technologies, Finland) calibrated and validated according to the

manufacturers instructions. Solar radiation S increased (P<0.05) RR and ST at all locations. Average TEWL rose as ambient heat load increased and was greater in S (94.3 vs. 77.1 g/m²; P < 0.01) compared to NS. Correlations between skin temperature and TEWL were highly significant for the loin (r = 0.55, P < 0.001), rib (r = 0.62, P < 0.001) and neck (r = 0.42, P < 0.001) while a tendency was noted for the rump (r = 0.23, P = 0.0807). There was no detectable relationship between udder ST and TEWL (P > 0.10). This study begins to address the solar radiation component contributing to individual parameters of heat stress. Further, closed-chamber TEWL provides a novel method to determine sweating rate in dairy cattle.

Key Words: Heat Stress, Dairy Cattle, Solar Radiation

T142 Effect of growth hormone on the expression of liver-enriched transcription factors in the bovine liver. S. Eleswarapu* and H. Jiang, *Virginia Tech, Blacksburg.*

Growth hormone (GH) plays an important role in a variety of physiological processes. A major target organ of GH is the liver, where GH regulates the expression of many genes involved in metabolism, detoxification and other functions of the liver. A possible mechanism by which GH affects gene expression in the liver is that GH alters the expression of liver-enriched transcription factors (LETFs), which in turn change the expression of other genes in the liver. As part of the long-term goal to investigate this possibility, we determined the effect of GH on the expression of nine LETFs, including hepatocyte nuclear factor (HNF)-1 α , HNF-1 β , HNF-3 α , HNF-3 β , HNF-3 γ , HNF-6, CCAAT/enhancer-binding protein (C/EBP)- α , C/EBP- β , and albumin D-element binding protein (DBP) in the bovine liver. Eighteen non-lactating and non-pregnant Angus cows were assigned randomly to three groups (n = 6 per group) and each cow received a single intramuscular injection of 500 mg of recombinant bovine GH. Liver biopsy samples were taken from group 1 cows 6 h after GH administration, group 2 cows 24 h after GH administration, and group 3 cows 1 wk after GH administration. Liver biopsy samples were also taken from group 3 cows 1 d before GH administration. Levels of the nine LETF mRNAs in these liver samples were quantified using ribonuclease protection assays. The levels of HNF-3 γ and HNF-6 mRNAs were higher (P < 0.05) in the liver samples taken from cows 24 h and 1 wk after GH administration than in the liver samples taken from cows 1 d before GH administration or 6 h after GH administration. The levels of other LETF mRNAs, including HNF-1 α , HNF-1 α , HNF-3 α , HNF-3 β , C/EBP- α , C/EBP- β and DBP mRNAs, were not different (P > 0.05) between these liver samples. Thus, GH can increase the expression of HNF-3 γ and HNF-6 mRNAs in the liver and these two LETFs may play a role in GH regulation of the expression of other genes in the liver.

Key Words: Growth Hormone, Liver, Transcription Factor

T143 Liver expression of growth hormone receptor 1A mRNA is decreased in dairy cows but not in beef cows at parturition. H. Jiang*¹, M. C. Lucy², B. A. Crooker³, and W. E. Beal¹, ¹Department of Animal and Poultry Sciences, Virginia Tech, Blacksburg, ²Department of Animal Sciences, University of Missouri, Columbia, ³Department of Animal Sciences, University of Minnesota, St. Paul.

Growth hormone receptor (GHR) mRNA in the liver of cattle is composed of variants that differ in the first exon. The expression of a major GHR mRNA variant, GHR 1A, is down-regulated in the liver of dairy cows at parturition. As part of the effort to understand the mechanism by which GHR 1A mRNA expression is decreased at parturition, we determined in this study if GHR 1A mRNA expression was also decreased in the liver of beef cows at parturition. Liver biopsy samples were taken from multiparous Angus (n = 6) and Holstein cows (n = 6) 7 to 23 d before parturition, within 24 h after parturition (i.e., at parturition), and 8 to 18 d after parturition, and the levels of GHR 1A and insulin-like growth factor-I (IGF-I) mRNA in these samples were measured by ribonuclease protection assays. As expected, the expression of GHR 1A mRNA in the liver of dairy cows was decreased at parturition (P < 0.05). The expression of IGF-I mRNA in the liver of dairy cows was also decreased at parturition (P < 0.05), perhaps as a result of decreased expression of GHR 1A mRNA. However, neither the expression of GHR 1A mRNA nor that of IGF-I mRNA was decreased in the liver of beef cows at parturition (P > 0.1), when compared to that in the prepartum or postpartum periods. These results suggest that the decrease in GHR

1A mRNA expression in the liver of dairy cows at parturition is not caused by ending of pregnancy or by initiation of lactation *per se*.

Key Words: Growth Hormone Receptor, Cows, Liver

T144 A miniature condition in Brahman cattle is associated with a single nucleotide mutation within the growth hormone gene. B. L. McCormack¹, C. Agca¹, C. C. Chase, Jr.², T. A. Olson³, T. H. Elsasser⁴, A. C. Hammond⁵, T. H. Welsh, Jr.⁶, and M. C. Lucy¹, ¹University of Missouri, Columbia, ²USDA, ARS, Brooksville, FL, ³University of Florida, Gainesville, ⁴USDA, ARS, Beltsville, MD, ⁵USDA, ARS, Athens, GA, ⁶Texas A&M University, College Station.

Miniature Brahman cattle at the USDA, ARS in Brooksville, FL have normal proportioned growth but are approximately 70% of normal mature height and weight. Pedigree analyses suggest that the condition is inherited as a recessive gene. The objective was to clone the GH cDNA from miniature cattle and compare its sequence to normal cattle. Messenger RNA was isolated from pituitary and a cDNA for the protein coding region of the GH gene was amplified by reverse transcription PCR from each of two miniature cattle. The cDNA were cloned into

plasmid vectors and the top and bottom strands were sequenced by automated DNA sequencing. Both cDNA clones contained a nucleotide polymorphism in which base number 641 of GenBank AF034386 (*Bos indicus* GH) was mutated from a cytosine (C) to a thymine (T). The C to T change encodes a mutation (threonine to methionine) at amino acid 200. The threonine is located in the fourth alpha helix of GH and is one of nine amino acids that participate directly in binding of GH to the GH receptor. Amino acid mutations at this location are associated with dwarfism in humans. Four miniature and four normal stature cattle from the Brooksville herd were tested for the polymorphism by using restriction fragment length polymorphism (RFLP) analysis of PCR-amplified GH gene with BsmBI restriction enzyme (specific for mutated nucleotide). The four miniature cattle were homozygous for the mutation (-/-). Two of the normal stature cattle were homozygous for the wild type allele (+/+) and two were heterozygous (+/-) ($P < .05$). Miniature Brahman cattle were homozygous for a single nucleotide polymorphism that encodes a mutation in an amino acid involved in binding of GH to the GH receptor. Normal stature cattle had at least one copy of the normal GH allele. We conclude that threonine 200 in bovine GH is required for normal growth in cattle.

Key Words: GH, Mutation, Growth

ASAS - Growth and Development

T145 Effect of gender and feeding program on productive performance and carcass quality of heavy pigs. J. Peinado^{*1}, M. Nieto², J. C. González¹, G. G. Mateos³, and P. Medel¹, ¹Imasde Agropecuaria Madrid, Spain, ²Copese Segovia, Spain, ³Universidad Politécnica de Madrid, Madrid, Spain.

A total of 252 Duroc x Landrace*Large White pigs of 28.3 ± 2.1 kg of initial BW was used to study the influence of sex and a 10 % lysine restriction from 30 to 60 kg BW on productive performance and carcass quality. There were six treatments arranged factorially with two types of feed from 30 to 60 kg BW (LL, 0.89 % lys vs HL, 0.97 % lys) and three sexes (castrated females, CF; entire females, EF; castrated males, CM). Energy:lys ratio was maintained constant in all the diets, and each treatment was replicated three times (14 pigs housed together). Males were castrated at birth and females at 30 kg BW. From 60 kg BW to slaughter all pigs received a common diet *ad libitum* (2.4 Mcal NE/kg and 0.70 and 0.67 % lys from 60 to 90 and from 90 to 119 kg BW, respectively). From 30 to 60 kg BW pigs fed the LL diet had worse feed conversion than pigs fed the HL diet (2.12 vs 1.97 g/g; $P < 0.05$). However, from 60 to 90 kg BW pigs fed the LL diet ate more and grew faster than pigs fed the HL diet (1,982 vs 1,815 g/d; and 688 vs 619 g/d for LL and HL diet, respectively; $P < 0.05$). For the whole period, pigs fed the LL diet ate 5.5 % more feed than pigs fed HL diet (1,983 vs 1,879 g/d; $P < 0.05$) but gains and feed conversion were not affected. Gender did not influence productive performance. Backfat was higher for CF than for EF with CM in an intermediate position (28.3, 23.3, and 25.4 mm, respectively; $P < 0.05$). Fat thickness at *Gluteus medius* muscle (GM) was higher for CF than for EF or CM (20.2, 17.9, and 18.6 mm, respectively; $P < 0.05$). Feeding program did not affect backfat or GM fat. It is concluded that a reduction of 10 % of lysine from 30 to 60 kg BW increased feed intake in the global period without affecting growth or feed conversion. Also, castration of the females might improve some quality carcass parameters of pigs destined to the cured ham industry.

Key Words: Pig Performance, Castration, Lysine Level

T146 Effect of protein from placental bovine tissue on puberty and growth mice. F. A. Nunez¹, J. A. Garcia-Macias¹, J. A. Lopez², and F. G. Rios^{*2}, ¹Facultad de Zootecnia - Universidad Autonoma de Chihuahua (Mexico) Periferico F. R. Almada, Mexico, ²FMVZ - Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico.

Our aim was to evaluate activity of protein from placental bovine tissue partially purified by chromatographic column with Sephadex 50-40#8482. Sixty Balb/C pubertal mice, (thirty females and thirty males), were used in a randomized design experiment with 3 x 4 factorial arrangement to test two sex (females and males), two placental proteins (PI and PII) and four placental proteins (25, 50, 75 and 100 μ g/mice/day of the placental protein). We compared this to a positive

control (100 μ g/mice/day) of bovine serum albumin (BSA) and negative control group (100 μ L/mice/day) of ammonium bicarbonate (AB). Four groups (three males and three females) received four dose, 25, 50, 75 and 100 μ g/mice/day of the placental protein PI (MW ranks 17 to 30 kDa), and four groups (three males and three females) received four dose, 25, 50, 75 and 100 μ g/mice/day of the placental protein PII (MW ranks 31 to 97 kDa). Body weight and feed intake were measured daily for a ten day experimental period. The experiment was analysed as factorial design randomised with three factors; means comparison performed by contrast. Feed efficiency (FE) of female mice (0.095g:g) and male mice (0.091) were not affected ($P \#88050.05$), by sex and treatments. The rate of growth (RG) observed a effect of sex; the male mice were heavier ($P \#88040.01$) in 44.82% than female mice (2.61 \pm 0.23 vs. 1.17 \pm 0.23). RG in the mice group injected with AB was less ($P \#88040.05$) than mice group injected with BSA (1.54 \pm 0.25 vs. 2.16 \pm 0.24), average daily gain (ADG) was different in male mice ($P \#88040.05$) in 29.1% than female mice (0.51 \pm 0.01 vs. 0.36 \pm 0.09g/d). In the mice group injected with AB and the mice group injected with 50 μ g/mice/d of PII proteins, ADG was less than the other treatments in the same sex ($P \#88040.05$). The female mice injected with 100 μ g/mice/d were less ADG. The carcass composition was not affected ($P \#88050.05$) by sex and treatments, 41.96 \pm 1.56 for male vs. 41.57 \pm 1.59, for female, however dressing carcass percentage observed lineal tendency ($P \#88040.05$) in PI and PII for male mice. It is concluded that proteins from placental bovine tissue partially purified, not improve growth in pubertal mice.

Key Words: Placental Protein, Mice, Growth

T147 Maternal undernutrition changes angiotensin type 1 and 2 receptors in ovine fetal heart. H.-C. Han^{*1}, K. J. Austin¹, S. P. Ford¹, P. W. Nathanielsz², and T. R. Hansen¹, ¹University of Wyoming, Laramie, ²New York University, New York.

Nutrient restriction during early gestation causes compensatory growth of both the left and right ventricles of the ovine fetal heart by day 78 of gestation (Biol Reprod 69:133). Angiotensin II mediates cardiovascular pathologies through its effects on the type 1 (AT1) and type 2 (AT2) receptors. AT1 has been shown to mediate deleterious effects such as vasoconstriction, cellular growth, and endothelial cell damage in adult systems. Very little is known about fetal heart angiotensin receptors and the consequences of activation. Previously we reported that AT1 mRNA was down regulated in fetal left ventricle (LV) from nutrient restricted ewes when compared to control fed ewes. It was hypothesized that maternal undernutrition (energy and protein) would adversely affect AT1 and AT2 protein expression in the fetal LV. Pregnant ewes were randomly assigned to control (n = 8, 100% NRC requirements) or nutrient-restricted groups (n = 8, 50% NRC requirements). Ewes were maintained on diets from day 28-78 of gestation. Fetal LV was

snap frozen on day 78 of gestation. Protein was extracted in a reducing environment (beta mercaptoethanol) using Laemmli buffer. Protein (100 µg) was separated using SDS-15% 1D-PAGE and transferred to nitrocellulose membranes. AT1 and AT2 were detected using antibody against AT1 or AT2. Immunoreactive bands were detected using chemiluminescence substrate. Data represent arbitrary units. AT1 was down regulated in fetal LV from nutrient restricted when compared to control fed ewes (1630 vs 1345 ± 78.72, pooled standard error; P < 0.05). A 50-kDa form of AT2 was also down regulated in nutrient restricted LV (3290 vs 2814 ± 149.52; P < 0.05) while a lower molecular weight form of AT2 (22kDa) was upregulated (7672 vs 11044 ± 880.69; P < 0.05) when compared to control fed ewes. It is concluded that hypertrophy of fetal LV in response to maternal undernutrition is associated with decreased AT1 and 50-kDa AT2, and increased 22kDa AT2 protein expression. Fetal LV gene expression in response to changes in the angiotensin receptors may have longer-term implications in development of cardiovascular disease during post-natal life. NIH P20RR16474.

Key Words: Ruminant, Fetal Heart, Angiotensin

T148 Microarray analysis of gene expression during ovarian development in swine. C. Agca^{*1}, K. M. Whitworth¹, J.-G. Kim¹, C. N. Murphy¹, A. Rieke¹, G. K. Springer¹, L. J. Forrester¹, J. A. Green¹, N. Mathialagan², R. S. Prather¹, and M. C. Lucy¹, ¹University of Missouri, Columbia, ²Monsanto Company, St. Louis, MO.

The objective was to measure global changes in porcine ovarian gene expression by using microarray analysis. cDNA clones from porcine reproductive tissues were isolated and sequenced. The cDNA insert from individual clones was amplified by PCR and arrayed onto polylysine-coated slides (n = 20,000 clones per slide). Clones were represented either once (75%) or multiple times (25%) on individual slides. Total RNA was isolated from fetal ovary (60 d of gestation), neonatal ovary (22 d of age), prepubertal ovary (150 d of age), or adult ovary [ovary or corpus luteum (CL)]. Duplicate samples from four animals per developmental stage were used in the analysis (n = 40 microarrays). A reference sample was generated by pooling total RNA from ovarian follicles and CL. Each microarray slide was hybridized to cy5 labeled test sample and cy3 labeled reference sample. The arrays were normalized and filtered using GeneSpring™ software (Silicon Genetics, Redwood City, CA). Statistical analysis was done using Welch t-test and Bonferroni multiple testing correction with 0.01% false discovery rate. A Tukey post-hoc test was used to determine differential expression among the developmental stages. Approximately 16,500 clones passed the filtering and 1148 genes (7%) showed evidence of differential expression in ovarian tissues (P < 0.01). Examples of genes found to be differentially expressed were: synaptonemal complex protein 3 and transportin 3 (fetal ovary); zona pellucida glycoprotein 3 and H19 (neonatal ovary); insulin-like growth factor binding protein 5 (fetal and neonatal ovary); connexin 43 (prepubertal ovary); apolipoprotein D (adult and prepubertal ovary); 3β hydroxysteroid dehydrogenase (adult ovary and CL); betamicroseminoprotein and major histocompatibility complex genes (CL). Distinct differences in gene expression across ovarian development were shown. This research was funded by the Monsanto Company.

Key Words: Ovary, Pig, Microarray

T149 Hormonal regulation of leptin receptor expression in primary cultures of porcine hepatocytes. T. J. Caperna^{*}, A. E. Shannon, S. M. Poch, W. M. Garrett, and M. P. Richards, USDA, Agricultural Research Service.

Leptin, a polypeptide hormone primarily produced by fat cells, has been shown to regulate energy metabolism in monolayer cultures of rodent hepatocytes and hepatic tumor cell lines. However, in porcine hepatocytes, we and others have demonstrated that leptin plays a minimal role, if any, in cellular energetics. The goals of this study, were to establish the presence of porcine hepatocyte leptin receptors and to determine the influence of regulatory hormones on leptin receptor gene expression. Hepatocytes were prepared from 30-70 kg pigs and seeded into T-25 flasks coated with pig tail collagen. Monolayers were established in Williams E medium containing fetal calf serum for one day and switched to serum-free medium with basal hormone conditions (1 ng/ml insulin and 10 nM dexamethasone) for an additional two days. For the final 24 hr, insulin (1 or 100 ng/ml) or glucagon (100 ng/ml), were added in the presence or absence of 100 nM T3. RNA was extracted and quantitative

RT-PCR was performed with primers specific for porcine long form and total leptin receptors. Leptin receptor expression was calculated relative to 18S rRNA expression. The expression of the long form of the leptin receptor was confirmed under basal conditions. Insulin, glucagon and recombinant human proteins at 100 ng/ml (ghrelin, GLP-1 and leptin) had no influence on leptin receptor expression, however, the addition of T3 was associated with a marked increase (P < 0.001) in total and long forms of the leptin receptor, 1.6 and 2.3 fold, respectively. Despite the presence of up-regulated leptin receptor expression in T3 treated cells, addition of leptin to these cultures confirmed the lack of effect of leptin on glycogen turnover or glucagon-induced cAMP production. These data suggest that porcine hepatocytes are insensitive to leptin even when leptin receptor expression is enhanced by T3.

Key Words: Pig Hepatocytes, Leptin Receptor, T3

T150 Regulation of leptin and leptin receptor expression in porcine subcutaneous adipose tissue. T. G. Ramsay^{*} and M. P. Richards, USDA-ARS, Beltsville, MD.

The present study was performed to examine the response of the leptin gene to hormonal stimuli in porcine adipose tissue from finishing pigs. Ten Yorkshire gilts (approximately 150 kg BW) were used in this study. Dorsal subcutaneous adipose tissue samples were acquired and adipose tissue explants (approximately 100 mg) were prepared using sterile technique. Tissue slices were then transferred to 12 well tissue culture plates containing 1 mL of media 199 with 25 mM Hepes, 0.5 % BSA, pH 7.4 and various hormone supplements of interest. Triplicate tissue slices were incubated with either basal medium or hormone supplemented media in a tissue culture incubator at 37° C with 95% air/5% CO₂. Following 24 h of incubation, tissue samples from these incubations were blotted and transferred to microfuge tubes with subsequent freezing in liquid nitrogen and storage at -80° C prior to analysis for gene expression by RT-PCR and subsequent quantification of transcripts by capillary electrophoresis with laser-induced fluorescence detection. Media from these incubations was collected in microfuge vials and stored at -20° C prior to analysis for leptin content by RIA. Dexamethasone (1 µM) reduced leptin secretion by 25% (p < 0.05), while the combination of insulin and dexamethasone stimulated leptin secretion into the medium by 60% (p < 0.05). Porcine growth hormone (GH) inhibited leptin secretion by 33% (p < 0.05). Neither triiodothyronine (T3, 10 nM) nor IGF-1 (250 ng/mL medium) had an effect on leptin secretion from adipose tissue slices (p > 0.05). Dexamethasone produced a 35% increase in leptin mRNA expression relative to insulin (p < 0.05). Incubation of tissue cultures with GH, T3 or leptin for 24 h had no effect on leptin mRNA expression (p > 0.05). Dexamethasone induced a 34% decrease in total leptin receptor expression, relative to insulin treated adipose tissue slices, following 24 h of incubation. Porcine GH, T3 and leptin had no effect on total leptin receptor expression (p > 0.05). These data suggest that leptin secretion is a regulated phenomenon and that post-translational processing may be significant.

Key Words: Leptin, Leptin Receptor, Adipose

T151 Secreted and signaling genes and proteins in fetal and neonatal pig adipose tissue and stromal-vascular cells. G. J. Hausman^{*1}, S. P. Poulos¹, L. R. Richardson¹, R. Barb¹, T. Andacht², R. Mynatt³, H. Pecot³, D. Crandall⁴, and A. Hreha⁴, ¹USDA-ARS, Athens, GA, ²University of Georgia, Athens, ³Pennington Biomedical Research Center, Baton Rouge, LA, ⁴Wyeth Research Labs, Philadelphia, PA.

Although microarray studies indicate unique and unexpected genes in human and rodent adipose tissue similar studies of meat animal adipose tissue have not been reported. Total RNA was isolated from 90 day fetal stromal-vascular (S-V) cell cultures (n=4; 2 arrays, 2 cultures / array) and subcutaneous adipose tissue from two 105 day-old fetuses and neonatal pigs. Dye labeled cDNA probes were hybridized to custom microarrays (70 mer oligonucleotides) representing 600 pig genes involved in growth and reproduction. Each of the four adipose tissue arrays represented RNA from a fetus and a pig with duplicate arrays / fetus and pig. Relative intensities of 25 irrelevant or reproductive oriented genes were averaged for both S-V cell culture arrays (150 ± 20) and all adipose tissue arrays (200 ± 40) and used to represent basal gene expression. A total of 391 and 340 genes were expressed 10 fold and 200 and 160 genes expressed 40 fold over basal in S-V cultures and adipose tissue, respectively. Relative intensities in adipose tissue arrays

(n = 4) included $20,360 \pm 2700$ for IGFBP-5, $19,800 \pm 2,800$ for relaxin, $7,360 \pm 1,260$ for leptin and $2,390 \pm 355$ for APO-A1. Collectively, 21 secreted protein genes and 40 signaling protein genes were expressed 40 fold in S-V cultures and adipose tissue. Additionally, the agouti gene was detected by RT-PCR in S-V cultures and adipose tissue. Proteomic analysis of adipose tissue and S-V culture conditioned media and cells identified several secreted and signaling proteins including APO-A1, APO-E, relaxin, IGFBP-5 and nitric oxide synthase. Another of the secreted proteins, PAI-1, was identified by ELISA in S-V culture media. These studies demonstrate for the first time the expression of several major secreted and signaling proteins in pig adipose tissue which may influence local and overall metabolism and growth.

Key Words: Adipocytes, Microarrays, proteomics

T152 IGF-I mRNA levels in bovine satellite cell cultures: Effects of fusion and anabolic steroid treatment. E. Kamanga-Sollo*, M. S. Pampusch, G. Xi, M. E. White, M. R. Hathaway, and W. R. Dayton, *University of Minnesota, St. Paul.*

Anabolic steroids enhance muscle growth in cattle; however, their mechanism of action is not known. The goal of this study was to determine if treatment of bovine satellite cell (BSC) cultures with 17 β -estradiol (E2) or trenbolone (T) directly affects proliferation rate or level of mRNA for estrogen receptor (ER)- α , androgen receptor, and growth factors that have been shown to affect muscle growth (IGF-I, IGFBP-3, and myostatin). BSC cultures established from semimembranosus muscles of steers were treated for 48 hours with concentrations of E2 or T ranging from 0.001 nM to 10 nM. IGF-I mRNA levels in proliferating BSC cultures were significantly increased at 0.01 (1.9 times control values, $p < 0.02$) and at 0.1, 1 and 10 nM E2 (2.9, 3.5 and 3.5 times control values, respectively, $p < 0.0001$). Both 1 and 10 nM T increased IGF-I mRNA levels to 1.7 times control values ($p < 0.02$). ER- α mRNA was detectable in BSC cultures, and levels were increased (2.3 times control levels, $p < 0.001$) in cultures treated with 0.001 nM E2 but not in cultures treated with higher concentrations of E2. Androgen receptor mRNA levels also were increased (1.5 times control levels, $p < 0.02$) in cultures treated with 0.001 nM T but not by treatment with higher concentrations of T. Levels of IGFBP-3 were increased (1.4 times control values, $p < 0.02$) by treatment with 0.001 nM E2 but not by treatment with high concentrations of E2. Myostatin mRNA levels were not affected by any concentration of either of the steroids. Although, levels of IGF-I mRNA were 10 times greater ($p < 0.02$) in fused BSC cultures than in proliferating cultures, treatment of fused cultures for 48 hours with 10 nM E2 increased IGF-I mRNA levels (2.5 times control levels, $p < 0.02$). Both E2 and T increased ^3H -thymidine incorporation rate (1.5 times control levels, $p < 0.001$) in BSC cultures in media containing serum from which IGFBP-3 had been removed. In summary, treatment of BSC cultures with either E2 or T increased IGF-I mRNA level and proliferation rate, thus, establishing that these steroids have direct anabolic effects on cells present in the BSC culture.

Key Words: Satellite Cell, Muscle, Steroid

T153 Production of recombinant porcine IGF-binding protein-5 (IGFBP-5) and its effect on proliferation of porcine embryonic myoblast cultures (PEMC) and L6 cells and on differentiation of L6 cells in the presence and absence of IGF-I. M. Pampusch, G. Xi, E. Kamanga-Sollo, M. White*, M. Hathaway, and W. Dayton, *Animal Growth and Development Laboratory, Department of Animal Science, University of Minnesota, St. Paul.*

IGF-binding protein (IGFBP)-5 is produced by cultured porcine embryonic myogenic cell (PEMC) cultures and is secreted into the medium. IGFBP-5 may play some role in myogenesis and/or in changes in myogenic cell proliferation that accompany differentiation. IGFBP-5 reportedly may either suppress or stimulate proliferation or differentiation of cultured cells depending on cell type. Additionally, IGFBP-5 has been shown to possess both IGF-dependent and IGF-independent actions in some cell types but not all. The goal of this study was to produce recombinant porcine IGFBP-5 and assess its IGF-I-dependent and IGF-I-independent actions on proliferation of PEMCs and L6 myogenic cells. To accomplish this, we have expressed porcine IGFBP-5 in the baculovirus system, purified and characterized the expressed recombinant porcine IGFBP-5 (rpIGFBP-5). RpIGFBP-5 suppressed IGF-I-stimulated proliferation of both PEMCs and L6 cells in a concentration-dependent manner ($P < 0.05$). RpIGFBP-5 also suppressed Long-R3-IGF-I-stimulated proliferation of PEMCs and L6 cells ($P < 0.05$), indicating that rpIGFBP-5 possesses IGF-independent activity in these cell

systems. Furthermore, rpIGFBP-5 stimulated differentiation of L6 cells as indicated by an increase in creatine phosphokinase (CPK) activity ($P < 0.05$). These data demonstrate that rpIGFBP-5 has the potential to affect proliferation and differentiation of both PEMCs and L6 myogenic cells during critical periods of muscle development that may impact ultimate muscle mass postnatally.

Key Words: Porcine, IGFBP-5, Muscle

T154 Effect of recombinant porcine IGFBP-3 on IGF-I and Long-R3-IGF-I-stimulated proliferation and differentiation of L6 myogenic cells. G. Xi*, E. I. Kamanga-Sollo, M. S. Pampusch, M. E. White, M. R. Hathaway, and W. R. Dayton, *Department of Animal Science, University of Minnesota, St. Paul.*

Insulin-like growth factor (IGF)-I stimulates both proliferation and differentiation of myogenic precursor cells. In vivo, IGFs are bound to one of the members of a family of six high-affinity IGF binding proteins (IGFBP 1-6) that regulate their biological activity. One of these binding proteins, IGFBP-3, affects cell proliferation via both IGF-dependent and IGF-independent mechanisms and it has generally been shown to suppress proliferation of cultured cells; however, it also may stimulate proliferation depending upon the cell type and the assay conditions. Cultured porcine embryonic myogenic cells produce IGFBP-3 and its level drops significantly immediately prior to differentiation. Additionally, IGFBP-3 suppresses both IGF-I and Long-R3-IGF-I-stimulated proliferation of embryonic porcine myogenic cells. In this study we have examined the effects of recombinant porcine IGFBP-3 (rpIGFBP-3) on IGF-I- and Long-R3-IGF-I-stimulated proliferation and differentiation of the L6 myogenic cell line. L6 cells potentially provide a good model for studying the actions of IGFBP-3 on muscle because they contain no non-muscle cells and they do not produce detectable levels of IGFBP-3. RpIGFBP-3 suppresses both IGF-I and Long-R3-IGF-I-stimulated proliferation of L6 cells, indicating that it suppresses proliferation via both IGF-dependent and IGF-independent mechanisms. Our data also show that rpIGFBP-3 causes IGF-independent suppression of proliferation without increasing the level of phosphosmad-2 in L6 cultures. Additionally, rpIGFBP-3 suppresses IGF-I-stimulated differentiation of L6 cells. In contrast, however, rpIGFBP-3 does not suppress Long-R3-IGF-I-stimulated differentiation. This suggests that rpIGFBP-3 does not have IGF-independent effects on L6 cell differentiation.

Key Words: IGF-I, IGFBP-3, Muscle

T155 Molecular cloning of untranslated regions of the porcine acid-labile subunit (pALS) gene and detection of pALS gene expression in hepatic and non-hepatic tissues. C. Y. Lee*, E. J. Jin, and I. A. Kim, *RAIRC, Jinju National University, Jinju, Korea.*

Tested primarily in this study was a hypothesis that there are untranslated regions including an intron in the gene of porcine acid-labile subunit (pALS) of the 150-kilodalton ternary insulin-like growth factor complex. The ALS gene consists of two exons separated by an intron in known species. Exons 1 and 2 code for the proximal region of the signal peptide and the rest of the pALS peptide, respectively. The nucleotide sequence of an exon 2 segment of pALS gene coding for the distal region of the signal peptide through the termination codon of pALS peptide has been previously reported from this laboratory. In the present study, the 5' and 3' untranslated regions (UT) of the gene were identified by rapid amplification of 5' complementary DNA end (5' RACE) and 3' RACE, respectively. A segment of the pALS gene spanning from the distal region of exon 1 through the proximal region of exon 2 coding for the proximal region of the pALS signal peptide was next amplified by polymerase chain reaction (PCR) using genomic DNA as template. The entire pALS coding sequence exhibited 85% and 83% homology to those of hALS and rALS genes, respectively, whereas 5' UT, 3' UT and intron sequences did not exhibit any significant homology to those of the human or rat. In-situ hybridization on pig liver slice using a pALS cDNA fragment revealed the gene expression in hepatocytes. Moreover, the ALS gene was also identified to be expressed in non-hepatic organs and tissues including the reproductive tract by reverse transcription-PCR using an intron-spanning primer pair.

Key Words: ALS, IGF, Gene

T156 Circulating levels of growth factors are influenced by physiological status in the horse. F. C. Buonomo*¹, D. L. Grohs¹, D. S. Ruffin², and J. L. Sartin², ¹Monsanto Company, St. Louis, MO, ²School of Veterinary Medicine, Auburn University, Auburn, AL.

Changes in endogenous growth factor levels have been well characterized in primates, rodents and food-producing species, but less in companion animals. While it has been demonstrated that horses respond to somatotropin by increasing insulin-like growth factor-I (IGF-I), the influence of physiological status on IGF-I and IGF-II levels in horses is not well known. Thus, we examined gender, age and breed differences on IGF-I and IGF-II in intact male and female horses over the first yr of development. A significant ($P < .02$) age effect was observed as IGF-I levels gradually declined over the first yr of life, but more rapidly between 6 & 12 mos. of age. The decline in IGF-I was similar between sexes. Effects of age ($P < .02$) and agexgender interaction ($P < .01$) were observed for IGF-II. The IGF-II developmental pattern in both genders was characterized by a spike in the otherwise relatively stable circulating levels during the first yr. IGF-II levels increased 110% in males at 3 mos. of age, followed by a decline at 6 & 12 mos. of age. A much smaller increase (17%) in IGF-II was observed in females at 6 mos. followed by a decline at 12 mos. An overall breed effect ($P < .05$) was observed for IGF-I, but not IGF-II (American Miniature < Quarter Horse < Draft Horse) during the first yr of life. IGF-I and IGF-II levels were then examined under conditions associated with reduced growth in foals by measuring serum IGF-I and -II in foals suckling mares housed on either endophyte-infected or endophyte-free fescue for 4 wks. At the end of 4 wks, mares and foals were switched to alternative pastures for 4 additional wks. IGF-I and IGF-II levels were lower ($P < .05$) in foals of mares grazing endophyte-infected pasture compared to those grazing endophyte-free pasture. Levels of both growth factors in foals on the endophyte-infected pasture did not return to normal after being transferred to an endophyte-free pasture for a period of 4 wks. These observations suggest that IGF-II, as well as IGF-I, plays an important role in growth and development during the first yr of life in the horse. Moreover, neonatal exposure to endophyte-infected fescue may have more long term consequences on subsequent growth and development.

Key Words: Growth Factor, IGF, Horse

T157 Effects of insulin, leucine, and glucose on translation rates in primary porcine satellite cells. B. A. Creamer*, J. M. Scheffler, and S. J. Jones, *University of Nebraska, Lincoln.*

Both insulin and branched-chain amino acids have shown to increase protein synthesis in rats, perfused muscle, and *in vitro* cultures of skeletal muscle myoblasts. This increase in synthesis has been shown to occur more readily at an early age, but this response declines with time. The objective of this study was to determine if insulin, glucose, and leucine caused a shift in the amount of ribosomes in the polysome state. We hypothesized that all three work independently to increase the amount of total ribosomes forming polysomes in primary porcine satellite cells (PSC) and in porcine satellite cell derived myotubes (PDM), *in vitro*. In both PSC and PDM, the addition of insulin at or above post-feeding physiological levels caused an increase in both total RNA and the percentage of ribosomes in polysome complexes when compared to controls ($p < .05$). A diminution of insulin to below physiological levels, in both PSC and PDM, caused a decline in both total RNA when reduced to half-physiological levels ($< .05$). This reduction was mimicked in polysome formation. Leucine caused similar results in both cell types; however, the increase in total RNA was much more pronounced, at 2-times control levels, in PSC than PDM (20% and 4% increase, respectively). When only glucose was excluded from the medium, total RNA and percent polysomes were reduced ($p < .05$), when compared to low (1g/L) and high (4g/L) glucose treatments. However, the increase from low to high glucose was not significantly different in either total RNA or percent polysome formation ($p > .05$). These data indicate that 1) insulin, leucine, and glucose increase total RNA production and percent polysome formation when present in increasing amounts, and 2) the absence of glucose decreases total RNA production and polysome formation, while addition, at both low and high levels, caused similar increases in both PSC and PDM.

Key Words: Translation, Insulin, Satellite cells

T158 Development of a microarray-based ELISA for the assessment of SR-associated calcium regulatory proteins in skeletal muscle. J. S. Schulz*, S. J. Jones, and M. Zeece, *University of Nebraska, Lincoln.*

A microarray-based ELISA approach was taken for development of a novel method to assess the levels of key calcium regulatory proteins in porcine skeletal muscle. Sarcoplasmic reticulum (SR) membrane preparations were generated by homogenization of longissimus muscle samples. The microarray technique is novel and has several advantages including: very small muscle sample requirement (2g), greater sensitivity (pg), lower analyte requirement ($< 50 \mu\text{L}$ per array) and capability multiplexed analysis of several target proteins on the same "chip". Membranes were solubilized by homogenization with buffer containing 30% sucrose, 5 mM imidazole pH 7.4 and protease inhibitors. Extracts (4.9 nl) were spotted onto microarray slides, and incubated at 37C for 2 hr with monoclonal antibodies to several target proteins including Ryanodine receptor (RyR) and dihydropyridine receptor (DHPR). Detection of bound antibody was accomplished using laser-induced fluorescence of a labeled secondary antibody. Microarray analysis of these targets was quantitated as fluorescence intensity per ng of protein spotted. The limit of detection has been found to be 15-20 pg of target protein. Coefficient of variation for this level of analyte ranges from 14 to 33%. Data from the protein microarrays can be compared with genomic analysis of the same animals. Microarray analysis will enable rapid determination of defects that alter levels of key proteins associated with abnormal calcium regulation and the subsequent development of PSE-like conditions in the meat.

Key Words: Microarray ELISA, Calcium, Proteomics

T159 Hormonal and metabolic responses to human handling in crossbred steers. K. Uetake*¹, T. Ishiwata¹, N. Abe², Y. Eguchi¹, and T. Tanaka¹, ¹School of Veterinary Medicine, Azabu University, Sagami-hara, Japan, ²Faculty of Agriculture, Tamagawa University, Machida, Japan.

Hormonal and metabolic responses to human handling, which can affect skeletal muscle growth, were determined with 35 Japanese Black \times Holstein steers. The steers were allocated into three pens (6.0 m \times 9.5 m each) after transport at 6-10 mo of age. They were provided commercial grain feed twice a day (830, 1500). They were allowed to access dry hay or oat straw on an ad libitum basis in the early or middle fattening stage. All steers were bimonthly driven into a crush 2 h later from the morning feeding and were weighed and blood collected. The relationships between concentrations of 7 hormones and 5 metabolites were determined using Pearsons correlation coefficients. The following integrated hormonal and metabolic responses were analyzed: In the early stage, increases in adrenaline (A) and noradrenalin (NA) secretion can cause an increase in plasma glucose (A: $r = 0.61$, $P < 0.001$; NA: $r = 0.53$, $P < 0.01$) and the depletion of serum vitamin A (A: $r = -0.38$; NA: $r = -0.42$, both $P < 0.05$), which could lead to an inhibition of insulin secretion ($r = 0.31$, $P < 0.10$). In addition, an increase in dopamine secretion might activate the depletion of serum triglyceride ($r = -0.29$, $P < 0.10$). In the middle stage, increases in the A and NA secretion can cause an increase in serum NEFA (A: $r = 0.31$; NA: $r = 0.32$, both $P < 0.05$) as well as a decrease in serum triglyceride (A: $r = -0.37$; NA: $r = -0.39$, both $P < 0.05$). It can also cause an inhibition of insulin secretion (NA: $r = -0.36$, $P < 0.05$) and the depletion of serum vitamin A (NA: $r = -0.33$, $P < 0.10$), which could lead to an inhibition of leptin secretion ($r = 0.38$, $P < 0.05$). Decreases in serum vitamin A and leptin could bring about a decrease in serum total cholesterol (vitamin A: $r = 0.35$, $P < 0.05$; leptin: $r = 0.30$, $P < 0.10$). In addition, an increase in cortisol secretion can cause steatolysis and an increase in serum NEFA ($r = 0.41$, $P < 0.05$). It is vitamin A that acts as intermediary between the stress responses and growth in steers.

Key Words: Cattle, Growth, Stress Response

T160 Skeletal development and productive performance of Italian Merino lambs as related to age. G. Maiorano*, F. Filetti, A. Ciarlariello, G. Gambacorta, and A. Manchisi, *University of Molise, Campobasso, Italy.*

To study skeletal development and productive performance of the Italian Merino sheep breed, 24 growing male lambs were slaughtered, in

groups equal for number, at 5, 30, 50 and 70 d of age. Lambs were naturally suckled, left to graze with their dams and allowed free access to a commercial diet. *In vivo* and *post mortem* performance were evaluated. Metacarpal (MC) and metatarsal (MT) bones were measured for length, diaphyseal diameter, weight, and moisture. MC growth plate width was also assessed after AgNO₃ staining. ANOVA was performed and comparisons were tested by Scheffé's test. ADG was 274, 299 and 256 g/d from d 5 to 30, 30 to 50, and 50 to 70, respectively. As age increased, slaughter weight (4.6a, 11.1b, 19.5c, 23.0d kg) and carcass (with head, thoracic organs, spleen, and liver) weight (2.9a, 7.4b, 12.2c, 14.1d kg) increased (P<0.05), but dressing (63.6a, 67.0b, 62.5a, 61.4a %) was the highest (P<0.05) at d 30. Loin eye area, indicative of carcass muscularity, increased (P<0.05) with age (3.0a, 7.6b, 10.3c, 11.2c cm²) up to d 50. Bones mainly grew longitudinally in the first month of age, with a following stop (9.8a, 11.0b, 11.5b, 11.7b cm for MC; 10.3a, 11.7b, 12.3b, 12.3b cm for MT; P<0.05). In the same period, growth plate, the site of longitudinal bone growth, has thinned (P<0.05) of about 35% (from 0.98 to 0.64 mm) and of another 24% in the following periods, reaching 0.40 mm at d 70. However, bone weight continued to increase (P<0.05) with age up to d 50, either in MC (15.5a, 24.1b, 30.2c, 32.6c g) or in MT (15.7a, 24.4b, 30.1c, 32.7c g) due to a persistence in development of transversal diameter (1.0a, 1.2ab, 1.3bc, 1.4c cm for MC; 0.9a, 1.0ab, 1.1bc, 1.2c cm for MT; P<0.05). Bone moisture, expression of bone chemical maturity, decreased (P<0.05) with age up to d 50, in both MC (49a, 38b, 29c, 25c %) and MT (49a, 38b, 27c, 23c %). The second month of age appears to be a critical period in lamb skeletal growth, which strictly related to development of muscular and adipose tissues, and influences carcass and meat quality.

Key Words: Lamb, Age, Skeletal Growth

T161 Regulation of myostatin (MSTN) and MyoD expression with acute inflammatory challenge in the channel catfish (*Ictalurus punctatus*). T. E. Weber*, D. J. Gregory, and B. G. Bosworth, *USDA/ARS, Stoneville, MS.*

In mammals, MSTN is implicated in the negative regulation of skeletal muscle growth. The muscle regulatory factor, MyoD, is important for muscle regeneration in mammals. Inflammatory mediators increase the expression of MSTN and decrease the expression of MyoD in skeletal muscle of mammalian species. Environmental stressors and glucocorticoids decrease the expression of MSTN in fish. This suggests species differences in the regulation of the expression of muscle regulatory factors in response to environmental stressors. Therefore, our aim was to determine the effect of an acute inflammatory challenge on MSTN and MyoD expression in muscle tissue, and whether alterations in mRNA abundance were related to an increase in circulating cortisol. A total of 36 fish (BW 46.1 ± 3.9 g) were randomly assigned to Control (saline; n = 18) or lipopolysaccharide (LPS, injected i.p. at 1.5 mg/kg BW; n = 18) treatments. Muscle and blood samples were collected at 3, 12, and 24 h relative to injection from six fish/treatment group at each time point. The abundance of MSTN and MyoD mRNAs was evaluated using real-time reverse transcriptase PCR procedures. Plasma cortisol was measured via a time-resolved fluoroimmunoassay. The abundance of MyoD mRNA was increased in LPS injected fish at 3 h (P = 0.05) and 10 h (P = 0.03) postinjection. At 24 h postinjection there was no (P = 0.89) difference in MyoD mRNA abundance between treatment groups. Injection with LPS did not alter the abundance of MSTN mRNA at 3 h (P = 0.85) or 10 h (P = 0.87) postinjection. However, the abundance of MSTN mRNA was decreased (P = 0.02) in fish injected with LPS at 24 h postinjection. Plasma concentrations of cortisol were not affected (P > 0.10) by LPS injection at any of the time points measured. These data suggest that MyoD is acutely upregulated, and that MSTN is downregulated in response to inflammatory stimuli in the channel catfish. In addition, these data further indicate that there are differences in the regulation of expression of muscle regulatory factors between mammals and fish in response to inflammatory stimuli.

Key Words: Catfish, MyoD, Myostatin

T162 Expression of the anti-apoptotic gene Bcl-2 during skeletal muscle development in normal and Low Score Normal chickens. C. S. Coy* and S. G. Velleman, *The Ohio State University, Wooster.*

Cell morphology and cell-extracellular matrix interactions play key roles in determining whether cells will undergo programmed cell death, apoptosis. Cell survival requires the appropriate interaction of the cell with the extracellular matrix. Low Score Normal (LSN) myogenic cells in culture exhibit a rounded morphology whereas normal myogenic cells are elongated with maximal attachment to the extracellular substrate. The rounded LSN cells undergo apoptosis most likely due to reduced contact of the cell with the extracellular matrix through the cell surface integrin receptors. In the current study, the expression of the anti-apoptotic gene Bcl-2 was measured during embryonic and posthatch pectoralis major muscle development in normal and LSN birds. During embryonic development, pectoralis major muscle tissue was analyzed every two d beginning at d 10 through 18 d, 19, 20, and 21 d. During posthatch development muscle samples were taken every two d through d 8, and then at 2, 4, and 6 wk, and 6 mo. Expression of the mRNA was measured by semi-quantitative reverse transcriptase-PCR using primers based on the chicken Bcl-2 sequence. The results from this study have shown at embryonic d 16 through 19, and posthatch d 6 and 8 that Bcl-2 expression was significantly reduced in the LSN pectoralis major muscle (P < 0.05). These data suggest that the appropriate expression of Bcl-2 is important for normal muscle development to occur by preventing cell death due to apoptosis.

Key Words: Extracellular Matrix, Bcl-2, Apoptosis

T163 Proteins were differentially expressed in the plasma from high and low feed efficient broilers. N. Pumford*¹, M. Iqbal¹, W. Bottje¹, J. Lay³, T. Wing², and M. Cooper², ¹Center of Excellence for Poultry Science, University of Arkansas, Fayetteville, ²Cobb-Vantress, Inc., Siloam Springs, AR, ³Statewide Mass Spectrometry Facility, University of Arkansas, Fayetteville.

Mitochondrial function and biochemistry have previously been linked to the phenotypic expression of feed efficiency (FE) in broilers (Bottje et al., 2002; 2003; Iqbal et al. 2004). Broilers were fed the same diet, provided same environment, and were from the same genetic line. Broilers, with low FE (g gain/g feed), though healthy, exhibit higher mitochondrial oxidative stress. In addition, proteins are differentially expressed in the mitochondria from low and high FE birds. The objective of this study was to investigate and identify proteins that expressed differentially in a readily available tissue such as plasma. Plasma from high (n=7) and low (n=7) FE broilers were initially separated using a one-dimensional sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS/PAGE). A protein with a molecular weight of 116 kDa was expressed 23% higher (p=0.03) in the plasma from the low feed efficient broilers compared to the high feed efficient broilers. To identify this protein the band at 116 kDa was excised from the gel and digested with trypsin into smaller polypeptides. The peptides were sequenced using matrix assisted laser desorption/ionization/time of flight (MALDI/TOF) mass spectrometry. The molecular masses obtained from the mass spectral analysis was compared to known masses in the Swiss Protein database using the program Protein Prospector. An antibody was obtained to the protein and the level of this protein was found to be significantly higher (p=0.01) in plasma from low feed efficient broilers in a Western blot format. The plasma proteins were also separated using a two-dimensional PAGE with the first dimension separating the proteins by charge and the second dimension by molecular weight. At least twelve plasma proteins were expressed over five fold differentially between high and low feed efficient broilers. Identification of proteins that are differentially expressed in a readily accessible tissue may aid in the development of a rapid, inexpensive, and cost effective assay to aid in progeny selection of broilers. This research was funded in part by USDA-NRI grant #2001-03443.

Key Words: Feed Efficiency, Proteomics, Breeder Selection

Lactation Biology: Lactational Physiology

T164 Effects of low doses of bST during transition period on milk component percentages and yields and milk production of Holstein cows. M. S. Gulay*¹, M. Liboni², A. Garcia³, M. J. Hayen², T. Belloso², and H. H. Head², ¹Department of Physiology, Burdur Veterinary Faculty, Akdeniz University, Burdur, Turkey, ²Department of Animal Sciences, University of Florida, Gainesville, ³Universidad del Zulia, Facultad de Veterinaria, Universidad del Zulia, Maracaibo, Venezuela.

Experiment was designed to evaluate whether supplementing Holstein cows with low doses of bST during the transition period affected milk constituent percentages and yields, and milk production. Data obtained from three hundred forty six multiparous Holstein cows from four separate trials were combined for analyses. Cows in bST supplemented group (n=177) received biweekly POSILAC[®] to provide approximately 5.1 or 10.2 mg bST/d beginning approximately 21 d (\pm 3 d) before expected calving and continued through 42 d (\pm 2 d) postpartum, whereas control cows (n=169) were not supplemented with bST during the same time period. Milk samples were collected the same day each week at three consecutive milkings during the first 9 wk of lactation for analyses of milk constituents. Proc Mixed procedure was used for data analyses and analyses were included treatment, trial, the two-factor interaction, and wk. No apparent calving problems were associated with bST. Overall, the percentages of fat and protein, and SCC were affected by trial ($P < 0.01$), but not the milk yield. During first 9 wk of lactation no differences due to bST were observed in percentages of protein (2.87 ± 0.02 vs. 2.85 ± 0.02) or fat (3.92 ± 0.04 vs. 3.92 ± 0.04). However, control cows had greater SCC than treated during the first 9 wk of lactation (438 ± 46 vs. $288 \pm 47 \times 10^3$; $P < 0.04$). Supplemented cows had greater mean yields of milk fat, milk protein and milk (1.54 ± 0.03 , 1.18 ± 0.03 and 39.4 ± 0.8 kg/d, respectively; $P < 0.01$) than non-supplemented control cows (1.41 ± 0.03 , 1.07 ± 0.03 and 36.2 ± 0.7 kg/d, respectively). The SCC of cows supplemented with a low dose of bST was significantly less even though MY of the treated cows was greater. This implies that a low dose of bST supplemented during transition period may have a potential role in reducing incidence of mastitis in dairy cows without affecting percent fat and protein in milk.

Key Words: Transition Cow, bST, Milk Constituents

T165 Response of milk yield and reproduction to bovine somatotropin (bST) in low and high producing Holstein cows. S. A. Mosley*¹, M. A. McGuire¹, W. Stouder², M. F. McGrath³, J. L. Vicini³, and S. C. Denham³, ¹University of Idaho, Moscow, ²Stouder Holsteins, Wendell, ID, ³Monsanto Co., Chesterfield, MO.

Sixty-four Holstein cows were selected on milk production from the top and bottom one-third of the herd. Cows were then blocked by parity and randomly assigned to receive bovine somatotropin (bST, Posilac, Monsanto Co.) or no injection starting the 9th or 10th wk of lactation. Biweekly bST injections continued up to 24 injection cycles. Monthly test day was used for milk yield, and body condition (5 pt scale by 0.25 units) determined by a single evaluator was recorded monthly. Reproductive data were recorded using the farms record system. The Proc Mixed procedure of SAS was used to evaluate the effects of parity, bST, production level, all possible interactions and a covariate representing the deviation from production level block. No significant effect of any interaction ($P > 0.2$) was detected for milk production but effects of parity ($P < 0.006$), production level ($P < 0.011$) and bST ($P < 0.07$) were detected. Multiparous cows produced 4.4 kg/d more milk than first lactation animals. Production levels across lactation were 34.6 and 30.6 kg/d for high and low groups. Response to bST across parities and production level was 2.9 kg/d. Over the entire lactation, average body condition was reduced in primiparous cows by both production level ($P < 0.0001$) and bST (3.20 for low control vs 3.08 for low bST compared to 3.01 for high control vs 2.96 for high bST; $P < 0.002$). In multiparous cows, average body condition was lower due to bST (0.25 points for low production cows and 0.14 points for high production cows; $P < 0.0001$). However, irrespective of production level or bST, body condition score increased from initiation of bST treatment to cessation of treatment. There were no differences in days open (primiparous = 99.6 d and multiparous = 123.9 d) or services per conception (primiparous = 2.0 services and multiparous = 2.7 services) due to production level or bST. High and low

producing cows respond to bST without any differential effects on reproduction.

Key Words: Bovine Somatotropin, Milk Yield, Body Condition Score

T166 Lactation persistence is enhanced in transgenic mice overexpressing des(1-3)hIGF-I in the mammary gland. D. L. Hadsell*^{1,2}, D. T. Torres^{1,2}, J. George^{1,2}, G. S. Shelton^{1,2}, and M. L. Fiorotto^{1,2}, ¹USDA/ARS Childrens Nutrition Research Center, Houston, TX, ²Baylor College of Medicine, Houston, TX.

Transgenic overexpression of IGFs within the mammary gland during lactation delays involution and inhibits apoptosis. The goals of this study were; 1) to determine if mammary apoptosis was associated with increased oxidative damage and decreased milk yield during prolonged lactation, and 2) to test the hypothesis that overexpression of des(1-3)hIGF-I within the mammary glands of transgenic mice (WAP-DES) would increase lactation persistence. Mammary morphology, apoptosis, proliferation and protein carbonyl content were compared among normal mice (N=3-13) during early and prolonged lactation. Persistence was compared among nontransgenic (N=9) and WAP-DES (N=13) mice by measuring the weight gain of cross-fostered litters (10 pups/litter) from day 14 to 35 postpartum. Apoptosis and proliferation were measured using immunohistochemical markers. Proliferation was highest on day 2 (6.3 ± 0.5 and 18.3 ± 1.8 % for phospho-histone H3 and BrdU, respectively) decreased dramatically on day 3 (1.8 ± 0.5 and 3.1 ± 0.2 %, respectively), and remained low throughout the rest of lactation. Apoptosis was low throughout lactation (0.3 ± 0.04 and 0.1 ± 0.01 % for TUNEL and active-caspase 3, respectively). Protein carbonyl content, as measured by dinitrophenyl-hydrazine reactivity, peaked on day 2 postpartum (0.4 ± 0.2 nmole/mg), decreased on day 5 (0.2 ± 0.1 nmole/mg), and remained low through the rest of lactation. Litter gain dropped in both nontransgenic and WAP-DES mice beginning on day 21 postpartum. By day 35, litter gain was 6.6 ± 2.6 and 2.4 ± 2.7 gm/wk for the WAP-DES and nontransgenic mice, respectively. Mammary gland wet weight at day 35 was also greater in WAP-DES mice than their nontransgenic counterparts (448 ± 24 and 346 ± 25 mg, respectively). Milk composition, however, was similar among genotypes. These data support the conclusion that neither increased apoptosis nor oxidative damage is responsible for declining milk yield during prolonged lactation. The data also support the conclusion that overexpression of des(1-3)IGF-I allows for the maintenance of a greater mammary tissue mass and enhanced lactation persistence. Supported by USDA NRI grant number 2001-35206-11145.

Key Words: IGF, Transgenic, Persistence

T167 IGF-I and TGF- α activate different upstream signaling molecules in bovine mammary epithelial cells. K. A. Hogan², U. Sivaprasad¹, G. Desury*¹, and W. S. Cohick¹, ¹Rutgers, The State University of New Jersey, New Brunswick, ²Rutgers, The State University of New Jersey and The University of Medicine and Dentistry of New Jersey, Piscataway, NJ.

IGF-I and TGF- α play critical roles in growth and development of the mammary gland. We have shown that these two growth factors stimulate DNA synthesis and IGFBP-3 expression in an additive manner in the bovine mammary epithelial cell line MAC-T. However, the molecular mechanisms by which this occurs are unknown. In MAC-T cells, IGF-I and TGF- α differentially activate Akt, a downstream signaling molecule in the phosphatidylinositol 3-kinase (PI3K) pathway, over time. TGF- α activates Akt transiently while IGF-I demonstrates a slower, prolonged activation of Akt. TGF- α also mediates the rapid and transient phosphorylation of ERK 1/2, a downstream component of the Ras/Raf/MAPK pathway. While basal activation of ERK 1/2 is readily apparent in untreated cells, further activation is not observed following IGF-I treatment. These data suggested that these two growth factors may signal through different upstream molecules. To test this hypothesis, cell lysates were collected from MAC-T cells treated with IGF-I (50 to 200 ng/mL) or TGF- α (2.5 to 100 ng/mL) over time. Activation of signaling molecules was determined by immunoprecipitation or immunoblotting using phosphospecific antibodies. Following IGF-I treatment, the IGF-I receptor was phosphorylated at 1 min, with maximal activation subsiding after 5 min. Immunoprecipitation of the IGF-I receptor docking protein IRS-1 revealed activation from 1 to 15 min,

and IRS-1 coimmunoprecipitated with the p85 subunit of PI3K. TGF- α did not activate IRS-1. Neither growth factor activated IRS-2, although total IRS-2 protein was detectable. TGF- α -mediated PI3K activation could involve direct binding of the p85 regulatory subunit with the EGF receptor (EGFR) or the Src tyrosine kinase. In contrast to IGF-1, TGF- α activated the adapter protein Shc (5 to 45 min), which explains its ability to activate ERK1/2. Therefore, the additive effects of IGF-1 and TGF- α on DNA synthesis and IGFBP-3 expression may be a consequence of divergence in the upstream signaling molecules recruited to their respective receptors.

Key Words: Mammary, IGF, TGF

T168 Expression of prolactin receptor, STAT5a, STAT5b and whey acidic protein in mammary tissue of lactating Large White and 50% Meishan sows. M. F. Palin and C. Farmer*, *Agriculture and Agri-Food Canada, Dairy and Swine R & D Centre, Lennoxville, QC, Canada.*

The association between mammary gland composition and prolactin receptor (PRL-R), whey acidic protein (WAP), STAT5a and STAT5b mRNA levels were investigated in sows. Twenty lactating 50% Meishan (GM) and 15 Large White (LW) sows were slaughtered on day 25 of lactation. Their mammary glands were collected for dissection of parenchymal and extraparenchymal tissues and tissue composition analyses. Parenchymal tissue samples were also collected, frozen immediately in liquid nitrogen and stored at -80°C until mRNA analyses. Semi-quantitative RT-PCR was performed to measure PRL-R, WAP, STAT5a and STAT5b mRNA expression levels. Data were analyzed using a Student's T test with breed as the main effect. Correlation analysis were calculated using the PROC CORR procedure of SAS. Levels of PRL-R mRNA (58.0 vs 43.3 ± 5.2 , $P < 0.05$) and of STAT5a mRNA (50.5 vs 26.9 ± 5.3 , $P < 0.01$) were higher in GM than in LW sows and there was a tendency for STAT5b to be higher in GM than in LW (58.6 vs 47.1 ± 5.7 , $P < 0.10$). Correlation analyses in the overall sow population showed associations between PRL-R mRNA levels and RNA concentrations ($r=0.41$, $P < 0.01$), total RNA ($r=0.33$, $P < 0.05$) and RNA/DNA ratio ($r=0.32$, $P < 0.05$) in parenchymal tissue. Such associations were not found in GM but were present in LW sows, with correlation coefficients of 0.51, 0.48 and 0.46 for RNA concentrations ($P < 0.05$), total RNA ($P < 0.10$) and RNA/DNA ratio ($P < 0.10$), respectively. In the overall sow population, there was an association between STAT5a mRNA levels and RNA concentrations in the parenchymal tissue ($r=0.34$, $P < 0.05$), but this association was not confirmed in GM or LW sows taken separately. There was no association between mammary gland composition variables and WAP or STAT5b mRNA levels ($P > 0.05$). The positive associations between the RNA content of lactating mammary glands and PRL-R and STAT5a mRNA levels suggest a possible involvement of the PRL-R signalling pathway in protein synthesis capacity of sow mammary glands.

Key Words: Mammary Gland, mRNA, Swine

T169 Expression of prolactin receptor (PRL-R) mRNA in somatic cells of bovine milk. K. J. Hohmann*, T. L. Auchtung, and G. E. Dahl, *University of Illinois, Urbana.*

Determination of the cellular function of the mammary gland using non-invasive techniques has practical implications for the dairy industry. Current research techniques utilize invasive biopsies of the mammary gland that can lead to health problems such as mastitis. Our objective was to assess the ability to use bovine somatic cells as an indicator of cellular function of the bovine mammary gland. Our laboratory has observed a positive relationship between PRL-R expression and milk production. In addition, we have established the importance of PRL sensitivity in management practices such as photoperiod and frequent milking. Therefore, we examined expression of PRL-R mRNA in somatic cells of bovine milk as an initial assessment of PRL sensitivity. To isolate the somatic cell fraction from milk, a minimum of 1 L of milk was separated into 20-50 mL fractions. The fractions were centrifuged for 10 min at $500 \times g$. The pellets were re-suspended in 5 mL of PBS and combined into 2-50 mL conical tubes. The tubes were then centrifuged for 10 min at $500 \times g$ and the pellets were suspended in 5 mL of Trizol. Expression of PRL-R mRNA was performed using real-time PCR, with 18S as the endogenous reference. Somatic cells from bovine milk were found to express PRL-R mRNA. Because the somatic cell fraction contains cells of epithelial origin as well as leukocytes, the

approach is being refined to further separate the somatic cells into lymphocytes, neutrophils, and epithelial (i.e., secretory) cells. Studies are underway to determine the differential expression of PRL-R in the various fractions of bovine somatic cells from animals milked at different frequencies. Observation that the somatic cell fraction contained cells that express PRL-R suggests that this approach may be a viable, non-invasive alternative to assess mammary function in lactating cows.

Key Words: Cattle, Somatic Cells, Prolactin Receptor

T170 Mammary cytokine gene expression during lactation. C. G. Prosser*, C. S. Smith, A. J. Hodgkinson, V. C. Farr, and E. A. Carpenter, *AgResearch.*

This study examined the expression of immune related genes in the mammary epithelium as a preliminary to understand the changes in immune function within the mammary gland occurring around parturition in dairy cattle.

Mammary secretory tissue was obtained from 6 Friesian-Jersey cross cows 221-235 days of pregnancy and 6 cows within 48 h of calving. Expression pattern of different immune or immune-related genes was measured by RT-PCR on total RNA extracted from the tissue.

The mRNA for IL-2, 6 10 and TNF- α were more highly expressed in tissue from all animals 48h post-calving. Whilst expression of IL-8, 12, 15 and 18 was more variable between animals, their expression levels were usually higher at this time. Very little IL-4 or 5 were detected and there was no change from pregnancy to colostrum.

A number of the cytokine genes observed to increase at the beginning of lactation are pro- or anti-inflammatory genes. The changes in their expression would indicate inflammation occurring naturally within the gland at this time in the absence of bacterial infection.

Key Words: Cytokines, Mammary, Bovine

T171 Effect of stage of lactation and parity on mammary gland gene expression. N. Miller*¹, L. Debecchi², D. Petitclerc², B. G. Talbot¹, and P. Lacasse², ¹Université de Sherbrooke, Quebec, Canada, ²Dairy and Swine R&D Centre, Lennoxville, QC, Canada.

Milk production persistency is a function of mammary epithelial cells number and activity. Therefore, factors that affect these parameters are very important for the determination of lactation persistency. Milk production tends to be higher in multiparous compared to primiparous cows, but, persistency is usually greater in primiparous cows. In this study, we compared the expression of several genes related to metabolic activity, apoptosis and endocrine control of mammary cell growth and development in 8 primiparous and 9 multiparous cows from calving to 250 days in lactation. Mammary gland biopsies were taken at early (d 10), peak (d 50) and late (d 250) lactation for gene expression evaluation. RNA isolation from mammary tissue was performed using Trizol reagent. RNA was converted to cDNA prior to analysis with real-time PCR using SYBR Green reagent. Expression of the 14 genes was normalized with the housekeeping gene GAPDH. As expected, milk production was higher ($P < 0.001$) in multiparous cows than in primiparous cows at the early and peak periods of lactation. However, milk production was the same during late lactation (23.9 kg/d). The expression of all genes related to milk synthesis was not significantly affected by the lactation stage. However, gene expression of acetyl-CoA carboxylase ($P < 0.05$), β -casein ($P < 0.05$), lipoprotein lipase ($P < 0.05$), fatty acid synthase ($P < 0.05$), and stearoyl CoA desaturase ($P < 0.05$) was lower during early lactation in primiparous cows. Expression of both the pro-apoptotic gene *bax* ($P < 0.01$) and the anti-apoptotic gene *bcl-2* ($P < 0.05$) were higher in primiparous cows and, therefore, the ratio *bax/bcl-2* was not changed. Expression of the *fos* gene was also higher in primiparous cows. There was no main effect ($P > 0.05$) of parity and stage of lactation on gene expression of IGF-1, IGFBP-5, prolactin receptor (long and short isoforms) and TGF- β 1. In conclusion, the level of expression of genes related to metabolic activity was lower during early lactation in primiparous cows than in multiparous cows suggesting a lower degree of cell differentiation in these animals. Differences in lactation persistency could not be related to the expression of any of the genes evaluated.

Key Words: Lactation, Persistency

T172 Long days do not alter mammary growth in prepubertal heifers. E. E. Connor¹, A. G. Rius², T. L. Auchtung², D. L. Wood¹, P. E. Kendall², G. E. Dahl², and A. V. Capuco¹, ¹USDA-ARS, Bovine Functional Genomics Laboratory, Beltsville, MD, ²Department of Animal Sciences, University of Illinois, Urbana.

Effects of photoperiod on growth and development have been demonstrated in many species. In cattle, long-day photoperiod reduces the age at puberty, increases growth rate and increases milk yield in lactating cows. Reported effects on prepubertal mammary growth are inconsistent. Discrepancies may be the result of separate influences of photoperiod on rate of mammary growth and duration of allometric mammary growth, which terminates peripubertally. Our objective was to evaluate mammary growth after exposure to long-day (16L:8D) or short-day (8L:16D) photoperiods during the prepubertal phase of mammary growth. Calves approximately 3 mo of age were assigned to short- or long-day photoperiods. Three calves were killed prior to treatment and 4 heifers per group were killed after 2 or 4 months of treatment (5 or 7 months of age). Effect of photoperiod on mammary growth measurements was analyzed by t-test. Photoperiod did not affect the mass of mammary parenchyma or mammary fat pad ($P > 0.05$), although both increased with age ($P < 0.05$). Similarly, total parenchymal DNA and parenchymal lipid content were unaffected by photoperiod ($P > 0.05$). These data indicate that mammary growth is not influenced by manipulation of day length during the prepubertal period.

Key Words: Photoperiod, Heifer, Mammary Growth

T173 Short term effects of different milking intervals on cisternal and alveolar milk in dairy sheep. V. Castillo*, X. Such, G. Caja, E. Albanell, and R. Casals, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Changes in volume and composition of milk stored in the cisternal and alveolar udder compartments at different machine milking intervals (4-, 8-, 12-, 16-, 20- and 24-h) were studied in 24 lactating ewes (Manchega, MN; $n = 12$; and, Lacaune, LC; $n = 12$) during mid-lactation. Cisternal milk was obtained by milking after i.v. injection of an oxytocin receptor blocking agent, and alveolar milk was milked removed after i.v. injection of oxytocin. Milk samples from each fraction were analyzed for composition and SCC. Total and cisternal milk accumulated linearly up to 24 h in both breeds. Alveolar milk increased up to 16 h in MN and 20 h in LC and was steady thereafter. Cisternal milk increased from 33 to 65% (MN), and from 47 to 76% (LC) for 4- and 24-h milking interval, respectively. Fat content in cisternal milk decreased from 8.3 to 5.8% (MN), and from 7.5 to 4.9% for 4- and 24-h milking interval, respectively. Alveolar milk fat content did not vary according to milking interval in MN, but increased in LC from 7.5 to 8.8% for 4- and 24-h milking interval. Protein content in cisternal milk increased in MN from 5.7 to 6.8% for 4- and 8-h milking interval, and did not change thereafter; no change was observed in LC (average 5.6%). Protein content in alveolar milk did not significantly vary according to milking interval in both breeds. True protein and casein contents changed in a similar manner as protein contents for both breeds. SCC values in total milk varied quadratically ($P < 0.01$) with milking interval and ranged between 5.26 and 5.10. The greatest logSCC in milk was observed at the 8-h milking interval (5.44; $P < 0.01$). Alveolar milk contained higher logSCC than cisternal milk at 16- (5.03 vs 4.95), 20- (5.09 vs 4.93), and 24-h (5.10 vs 4.85) milking intervals. Our results suggest that the cistern plays an important role in accommodating milk at extended milking intervals in dairy sheep. Milking frequency affected cisternal and alveolar composition and quality.

Key Words: Milking Frequency, Dairy Ewes, Milk Partitioning

T174 The use of ¹³C labeled fatty acids to study milk fat synthesis in dairy cows. E. E. Mosley* and M. A. McGuire, *University of Idaho, Moscow.*

The objective of this study was to evaluate methodology where ¹³C labeled fatty acids are utilized to study fatty acid synthesis in lactating dairy cattle. The incorporation of ¹³C labeled fatty acids into milk lipids was determined. Potassium salts of 5 g myristic-1-¹³C acid (14:0), 40 g palmitic-1-¹³C acid (16:0), or 50 g stearic-1-¹³C acid (18:0) were separately infused into the abomasums of ruminally cannulated primiparous Holstein cows ($N=3$) during two treatment periods of either bolus administration of the ¹³C labeled fatty acids over 20 min or continuously

over 24 h. Following initial infusion, milk samples were taken by hand every 2 h for 48 h (12 samples each day). During this time, milk samples were also taken every 4 h after complete milking by machine (6 samples each day). Milk fat was extracted using chloroform:methanol. Fatty acids were converted to fatty acid methyl esters (FAME) by base catalyzed transesterification. The FAME were converted to dimethyl disulfide derivatives (DMDS). The FAME and DMDS were analyzed by gas chromatography mass spectrometry. Data obtained from hand and machine milk samples were similar. The ¹³C enrichments from the bolus infusion were 4.9, 3.0, and 2.9% for 14:0, 16:0, and 18:0, respectively, at 4 h post infusion and peaked at 8 h (5.7, 7.2, and 5.3%, respectively). Enrichments for continuous infusion were 2.0% for 14:0, 1.6% for 16:0 at 4 h and 0.7% for 18:0 at 8 h, and peaked at 28 h for 14:0 (3.8%), from 20 to 28 h for 16:0 (3.5%), and from 20 to 24 h for 18:0 (1.7%). Enrichment was also detected in delta-9 desaturase products for both bolus and continuous infusions. Bolus infusion enrichments of 5.4, 1.7, and 2.1% were detected at 4 h for 14:1, 16:1, and 18:1, respectively, and peaked at 8 h for 16:1 (2.9%) and 18:1 (3.6%), and at 4 h for 14:1 (5.4%). Continuous infusion enrichments were 1.8% for 14:1 and 1.0% for 16:1 at 8 h, and 0.7% for 18:1 at 12 h, and peaked at 28 h for 14:1 (3.2%), and at 20 h for 16:1 (2.4%) and 18:1 (1.0%). Fatty acid synthesis and desaturase activity in the mammary gland can be studied using ¹³C labeled fatty acids. Funded by the United Dairymen of Idaho and USDA-NRI.

Key Words: ¹³C Labeled Fatty Acids, Milk Fat Synthesis, Desaturase

T175 Duration of starvation required to decrease milk production in the high-producing dairy cow. C. A. Toerien* and J. P. Cant, *University of Guelph, Guelph, ON, Canada.*

Milk synthesis can be decreased through feed removal. Our objective was to determine the length of starvation required to decrease milk production in the high-producing dairy cow without inducing detrimental metabolic effects. Holstein cows ($n=3$; 49 ± 2 kg milk/d; 45 ± 2 DIM) consuming TMR with ad lib intake were starved for a 24-h period, and refed for 18 h. Cows were milked and milk, blood and urine samples were collected at 0 h relative to the start of starvation, and every 6 h thereafter. During the starvation period, each cow received alfalfa hay (kg DM) at 6 h (3.4) and 18 h (2.8) to minimize the possible occurrence of ketosis. Compared to baseline values, milk production and its components were maintained for 18 h, possibly in part through the role of cortisol in mobilizing body reserves, thereby maintaining milk precursor availability. Cortisol levels increased during starvation and at peak were 7.5 times that at baseline. However, between 18 and 24 h of starvation, cortisol (-79%) and milk production (-31%) decreased sharply. Milk production remained at the same level ($P > 0.1$) for 6 h before responding to refeeding. No clinical signs of ketosis were observed and cows consumed feed readily upon refeeding. Mean milk production (kg/d) during 3 d prior to and 3 d after the experiment, were similar (47.2 ± 2.1 vs 46.6 ± 2.6 ; $P > 0.1$). In conclusion, in the high-producing dairy cow, 42% decrease in milk production can be achieved through a 24-h starvation period.

	Time (h)								
Item	0	6	12	18	24	30	36	42	SE ¹
Milk, kg	12.7	10.9	12	10.7	7.4*	7*	10.5*	14.6	0.88
Milk protein, g	339	280	299	276	201*	200*	279	365	30
Milk fat, g	676	604	536	555	470*	418*	483	511	40
Lactose, g	614	517	565	496	330*	324*	512	705	70
Plasma cortisol, pg/mL	50	53	224*	375*	81	31	41	121	30
Urinary ketones, mM	0.95	0.95	0.95	2.8	4.4	5.4	5.8	4.2	1.8

* Values differ ($P < 0.05$) from baseline (0 h).

¹ Pooled SE of the lsmeans.

Key Words: Starvation, Milk Yield, Dairy Cow

T176 Lactational response to annual or biannual kidding in dairy goats. A. A. K. Salama*, G. Caja, X. Such, R. Casals, and E. Albanell, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Extended lactation may reduce the number of days dry within the animal lifetime and metabolic stress. The effects of an annual lactation cycle vs a two-year extended lactation were evaluated in 30 multiparous Murciano-Granadina dairy goats milked once-a-day throughout lactation. Goats were assigned to treatments at wk 29 of lactation and mated (M, n = 14) or kept open (O, n = 16). Milk yield (weekly from wk 2) and milk composition (biweekly from wk 30) were recorded up to wk 72. Cisternal and alveolar milk were evaluated at wk 39 (wk 10 of pregnancy) and 55 (wk 5 of subsequent lactation) by using an oxytocin receptor blocking agent (Tractocile, Ferring S.A., Madrid, Spain). Average milk yield during the first 29 wk was 2.28 L/d. Pregnancy reduced ($P < 0.05$) milk yield at wk 39 (1.19 vs 1.51), 40 (1.02 vs 1.53), 41 (0.55 vs 1.40), and 42 (0.30 vs 1.41) of lactation for M and O goats, respectively. From wk 43 to 50, M goats were in dry-off, whereas, O goats yielded 1.43 L/d. After kidding (wk 51 to 72), M goats produced

40% more milk than O goats (2.50 vs 1.51 L/d; $P < 0.001$). Milk of M goats contained lower ($P < 0.05$) log SCC (5.99 vs 6.49) than O goats. No significant changes were detected for fat, protein or lactose contents. Cisternal milk at wk 39 was lower for M than O goats (638 vs 1560 ml; $P < 0.01$), whereas, alveolar milk did not differ (345 ml). In the following lactation (wk 55) cisternal milk in M goats tripled (2063 ml) and was higher ($P < 0.01$) than in O goats (1218 ml). Similarly, alveolar milk doubled in M goats (680 ml) and was higher ($P < 0.01$) than in O goats (355 ml). Fat content was higher ($P < 0.05$) for alveolar milk (6.18%) than cisternal milk (3.74%) except for M goats at wk 39. No differences in percentages of protein and lactose, or in log SCC were detected between cisternal and alveolar milk, although cisternal milk of M goats contained lower SCC than alveolar milk at wk 55 (5.84 vs 6.09; $P < 0.05$). In conclusion, differences in milk yield between groups were clear in the last third of pregnancy and at the peak of the following lactation. Throughout 72 wk, extended lactation slightly decreased milk yield (6.9%) in our conditions.

Key Words: Pregnancy, Extended Lactation, Dairy Goats

Ruminant Nutrition II

T177 Feed intake, nutrient digestibility and nitrogen retention in beef steers fed a total mixed ration supplemented with monensin or different doses of essential oils. C. Benchaar*^{1,2}, E. Charmley³, and J. Duynisveld³, ¹*Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville, QC, Canada*, ²*Nova Scotia Agricultural College, Truro, NS, Canada*, ³*Crop and Livestock Research Centre, Agriculture and Agri-Food Canada, Nappan, NS, Canada.*

Five steers (Angus x Herford, initial BW = 244 ± 21 kg) were used in a 5 x 5 Latin square design to study the effect of dietary addition of monensin (Rumensin[®]; MO) or a commercial mixture of essential oils (Vertan[®]; EO) on feed intake, nutrient digestibility and nitrogen retention. The mixture of EO consisted of thymol, eugenol, vanillin and limonene. Steers were fed once daily for *ad libitum* intake a total mixed ration consisting of 75% of grass/legume silage and 25% of rolled barley (dry matter basis), unsupplemented (Control, CO), or supplemented with MO (220 mg/d) or with different dose levels of EO (2, 3, and 4 g/d). Each experimental period consisted of three weeks of adaptation to the experimental treatment and one week for data recording and sample collection. Data were statistically analyzed as a 5 x 5 Latin square design using the PROC MIXED procedure of SAS. Specific prior contrasts were used to test differences between CO and diets supplemented with MO and EO, and to determine the linear or quadratic response to EO dose level. Dry matter intake was not affected by the addition of MO (5.8 kg/d; $P > 0.05$). However, it was higher for steers fed EO compared to those fed CO (6.3 vs 5.8 kg/d; $P < 0.05$), and linearly increased ($P < 0.05$) with increased dietary levels of EO. Apparent digestibility of dry matter was not changed by the addition of EO or MO to the diet (70.1%; $P > 0.05$). Nitrogen digestibility was not affected by feed additives (63.3%; $P > 0.05$). However, a quadratic tendency ($P = 0.08$) was observed for EO levels in the diet. Nitrogen digestibility was increased by the addition of 2 or 3 g of EO/d, but it was decreased with the highest dose of EO. Nitrogen retention was not different ($P > 0.05$) between steers fed CO and steers receiving MO or EO. Results from this study indicate that the addition a commercial mixture of EO increased DM intake and improved nitrogen utilization in beef cattle.

Key Words: Monensin, Essential Oils, Steers

T178 Effects of phase feeding of protein on performance, blood urea N, manure N:P ratio, and carcass characteristics of feedlot cattle. J. T. Vasconcelos*¹, L. W. Greene¹, N. A. Cole², and F. T. McCollum, III¹, ¹*Agricultural Research and Extension Center, Texas A&M University, College Station*, ²*USDA-ARS, Bushland, TX.*

One hundred eighty four steers (BW = 406 kg) were used in a randomized block design to determine the effects of phase feeding protein on performance, blood urea N (BUN), manure N:P ratio, and USDA carcass characteristics. Steers were assigned to 22 pens and fed *ad libitum* a finishing diet formulated to contain 10% roughage and 13% CP (DM basis). When steers reached 477 kg the diets were either maintained at

13% CP or reduced to 11.5% CP or no supplemental CP (approximately 10% CP). Steers were harvested when they had approximately 25 mm of external fat. Reducing the CP to 11.5% or no supplemental CP did not affect ($P = 0.21$) ADG of steers (1.62, 1.71 and 1.53 kg/d for 13%, 11.5% or no supplemental CP, respectively) from day of diet change to day of harvest. The ADG of steers was similar ($P = 0.09$) throughout the finishing period regardless of level of CP treatment (1.69, 1.86, and 1.74 for approximately 10% CP, 11.5% CP and 13% CP, respectively). Similarly, dry matter intake and feed efficiency did not differ ($P > 0.05$) among treatments. BUN concentrations were determined (mg/dL) on d 1, day of the diet change, and immediately before harvest. Differences ($P < .0001$) in BUN were observed only immediately before the harvest. Steers fed the 13% CP diet had greater ($P < .0001$) BUN concentration (13.85 mg/dL) than steers fed the 11.5% and no supplemental CP (12.08 and 10.04 mg/dL, respectively). Manure from the pen surface was collected and analyzed for N and P. No differences ($P > 0.05$) were observed in N ($P = 0.60$) and P ($P = 0.93$) concentrations among the different dietary treatments. The N:P ratio, however, was different ($P = 0.038$). The N:P ratio was influenced by treatment ($P = 0.04$), and was greater (3.87) for manure from 10% CP diets than for 11.5% or 13.0% diets (3.45 and 3.56, respectively). Carcass characteristics of steers did not differ ($P > 0.1$). Data indicate that under the condition of this study CP levels can be reduced during the final stages of finishing without effects on feedlot performance.

Key Words: Feedlot, Nitrogen, Environment

T179 Influence of sodium caseinate infusion on voluntary feed intake and digestive function in steer calves fed a Sudangrass-based growing diet. E. G. Alvarez*¹ and R. A. Zinn², ¹*Universidad Autonoma de Baja California, Mexicali, Mexico*, ²*University of California, Davis.*

Four medium-frame steer calves (269 kg BW) were used in a 4 x 4 Latin square experiment. Treatments consisted of infusing 300 g/d of Sodium Caseinate into: 1) the rumen (Rmn), via the rumen cannula; 2) the abomasum (AbR), via rumen cannula; 3) the abomasum (Abm), via the abomasal cannula and 4) the proximal duodenum (Ddn), via the duodenal cannula. Steers were allowed *ad libitum* access to the basal forage-diet (sudan grass, 87.6%). There were no treatment effects ($P > .20$) on dry matter intake (DMI; 97 g/kg BW^{0.75}), and flow of OM, and NDF to the small intestine. Casein infusion did not affect ($P > .20$) ruminal degradability of dietary N. There were no treatment effects ($P > .20$) on ruminal NDF digestion. However, ruminal ADF digestion was greater (5%, $P < .05$) when casein was infused post-terminally then when it was infused ruminally. There were no treatment effects ($P > .20$) on total tract digestion of OM, N, ADF, NDF, and GE. Casein infusion did not influence ($P > .20$) flow of chyme to the small intestine or ruminal turnover. Post-ruminal casein infusion increased (75%, $P < .01$) the soluble N content of duodenal chyme, but it did not affect ($P > .20$) its tonicity, averaging 264 mOsm. The relationship between tonicity and passage rate of chyme from the abomasum was small ($R^2 = .05$). Casein infusion did not affect ($P > .20$) ruminal DM content or

liquid volume, averaging 17.5 g DM / kg BW.75, and 471 g / kg BW.75, respectively. Casein infusion did not affect ($P > .20$) ruminal pH, but ruminal acetate:propionate molar ratio was greater ($P < .10$) when casein was infused ruminally. Ruminal acetate:propionate molar ratio was also greater ($P < .05$) when casein was infused into the abomasum versus the proximal duodenum. Protein content of chyme leaving the abomasum does not have an important role in the regulation of intake in steers fed forage-based diets.

Key Words: Casein, Regulation, Intake

T180 Ruminal ammonia load improves nitrogen retention of growing steers when leucine is limiting. M. S. Awawdeh*, E. C. Titgemeyer, K. C. McCuiston, and D. P. Gnad, *Kansas State University, Manhattan.*

We tested the hypothesis that ammonia loading might negatively impact amino acid (AA) utilization by cattle by increasing AA degradation in support of ureagenesis. Six ruminally cannulated Holstein steers (189 kg BW) housed in metabolism crates were used in a 6x6 Latin square to study effects of a rumen ammonia load on leucine (Leu) utilization. All steers received a basal diet (83% soybean hulls, 7% wheat straw, and 0.3% urea) twice daily at 2.7 kg DM/d, ruminal infusion of 200 g/d acetate, 200 g/d propionate, and 50 g/d butyrate, and abomasal infusion of 300 g/d glucose and a mixture containing all essential AA except Leu. Treatments were arranged as a 3x2 factorial and included Leu (0, 4, or 8 g/d) infused abomasally and urea (0 or 80 g/d) infused ruminally to provide an ammonia load. Periods were 6 d, with 2 d for adaptation and 4 d for fecal and urine collection. There was no Leu x urea interaction for fecal, urine, or retained N. Infusion of urea increased ($P < 0.05$) rumen ammonia concentrations from 9.0 to 27.0 mM and plasma urea concentrations from 4.3 to 6.8 mM. Urea infusion increased ($P < 0.05$) urinary excretion of total N from 47.1 to 80.0 g/d, urinary urea N excretion from 33.9 to 65.4 g/d, and retained N from 22.4 to 26.2 g/d. Leucine supplementation linearly decreased ($P < 0.05$) excretions of total urinary N, urinary urea N, and fecal N, and linearly increased ($P < 0.05$) retained N from 21.4 to 24.5 and 26.9 g/d for 4 and 8 g/d Leu, respectively. The efficiency of deposition of supplemental Leu ranged from 0.24 to 0.43 when steers received 0 or 80 g/d urea, respectively. Serum insulin and IGF-1 concentrations were not affected by treatments. Although environmentally unfriendly, an excess dietary N supply improved utilization of Leu for protein deposition by growing steers when Leu supply was limiting. (Supported by NRI Competitive Grants Program/CSREES/USDA, Award No. 2003-35206-12837.)

Key Words: Growth, Leucine, Ammonia

T181 Effect of fall protein supplementation with a self-feeding liquid supplement on performance of beef cows grazing tallgrass-prairie range. D. A. Llewellyn*¹, B. T. Gray¹, T. T. Marston¹, and C. A. Bandyk², ¹*Kansas State University, Manhattan*, ²*Quality Liquid Feeds, Inc., Dodgeville, WI.*

An experiment was conducted to evaluate the effect of providing a liquid, high-protein supplement during the fall on beef cow and calf performance. One hundred twenty-two mature, pregnant, spring-calving cows were assigned to supplementation treatments in a randomized complete block design. Twelve fall pastures were used providing four replications per treatment. Control cows received no fall supplementation and then a meal supplement (40% CP; as-fed basis) from 12/17 until calving. Fall supplemented cows were either allowed access to a liquid protein supplement (40% CP; as-fed basis) approximately 2 months before weaning until calving (fall supplementation from 8/14 to 12/17) or from weaning until calving (fall supplementation from 10/15 to 12/17). Supplement intake of the control cows was adjusted to match the estimated intake of the liquid-fed groups (prorated and hand-fed 3 d/wk). Fall supplementation did not affect cow body weight (BW) or body condition score (BCS) changes before weaning. Cows receiving the liquid supplement tended ($P = 0.08$) to gain BW more rapidly and had greater ($P = 0.03$) BCS gains after weaning (10/15). The rate of gain of calves suckling fall-supplemented cows (8/14 to 10/15) was not affected ($P = 0.83$) by fall supplementation. Control cows gained more BW and BCS ($P < 0.01$) during the winter (12/17 to 2/5), were heavier ($P = 0.03$), and had greater ($P = 0.04$) BCS at calving. Fall supplementation did not affect ($P = 0.39$) calf birth weight or subsequent pregnancy rate ($P = 0.36$). Calves produced by control cows gained more BW ($P < 0.01$; birth to May 2) and were heavier ($P < 0.01$) at the start of the grazing

season. In conclusion, fall supplementation increased cow BW and BCS gains from weaning until the start of the winter grazing season. Cows not supplemented during the fall had the ability to compensate for their lower previous nutrition when properly supplemented during the winter.

Key Words: Beef Cattle, Protein, Supplementation

T182 Amino acids degradation of rumen incubated feeds. M. Q. Manella¹, C. Boin², G. F. Alleoni¹, J. J. A. Demarchi¹, and L. O. Tedeschi*³, ¹*Instituto de Zootecnia, Heitor, Nova Odessa, Brazil*, ²*Esalq-Usp Av. Pádua Dias, Piracicaba, Brazil*, ³*Cornell University, Ithaca, NY.*

Six rumen-cannulated Nellore steers were used in two latin-square design with 3 treatments and 3 periods to evaluate the effects of different ratios of concentrate (20, 40, 60%) on amino acids (AA) degradation (%) after 12h of rumen incubation, corrected for ruminal microbial contamination. Six feeds were evaluated: soybean hulls (SBH), corn (C), sorghum grain (S), soybean meal (SBM), cottonseed meal (CSM) and corn gluten feed (CGF). There was a significant effect of feed ($P < 0.05$) on AA degradation in which S had the lowest and CGF had the highest degradabilities. Total ruminal degradation of the true protein for SBH, C, S, SBM, CSM, and CGF were 75.3, 76.8, 65.2, 82.4, 76.4 and 92.6%, respectively. The individual AA degradability for each feed was highly variable among feeds, depending on its characteristics, especially Ly, Met, Leu, Ile, and Val. The Met degradation compared to the mean degradation of total AA, was numerically higher (3.6 and 4.1%) for CGF and CSM, but for SBH it was significantly higher (4.8%, $P < 0.05$). The Met of C and S grains had lower ($P < 0.05$) degradability (-14.1 and -3.9%) and did not alter (1.4%, $P > 0.10$) for SBM. The Lys degradation of S were 19% ($P < 0.05$) higher ($P < 0.05$); however, it did change for the other feeds ($P > 0.05$). On average, Val, Leu and Ile had similar or even lower degradabilities than total AA, especially for Ile and Leu. On the other hand, the degradability of Val, Leu and Ile for SH was 12, 8, and 7%, respectively. Leu degraded less on S and C (-6.5 and -6.1%, $P < 0.05$) and showed no alteration to the other feeds. Ile degradability for S, CGF SBM, C, CSM were -2.8 ($P < 0.05$), 0.5, -0.2, 0.4 e -1.5%, respectively. Similarly, Val degradation was variable among feeds; it was higher for C and S (3.9 and 7.1%, $P < 0.05$), numerically lower for SBM (-3.5%), but were similar for CGF and CM compared to the total amino acid degradability (0.9 and -1.8%). The differences between AA degradability of the six feeds may be related to the protein structure for the protein feeds, and how it's associated to the protein fractions, which might have resulted on AA profile changes after rumen degradation. These interactions must be accounted for on future revisions of the feed evaluation systems.

Key Words: Aminoacids Degradation, Rumen, Protein

T183 Feedlot cattle responses to reduced levels of degradable protein. J. W. Lehmkuhler*, S. C. Arp, and D. M. Schaefer, *University of Wisconsin, Madison.*

Two feedlot trials were conducted to evaluate responses to lowered dietary crude protein level by reducing supplemental degradable protein addition. Experiment 1 involved 70 calf-fed steers (initial wt.=296 kg) that were offered rations including supplemental protein levels and forms of 0.5% urea (U), 2% Bloodmeal (BM), 2% BM + 0.5% U (BMU), or 1% U + 3% soybean meal (POS). Basal ingredients consisted of approximately 79% corn, 12% corn silage, and 9% supplement. Steers were blocked by source into 12 pens with 5-6 animals per pen. Steers were implanted with an estrogenic implant. Steers were harvested when ultrasound estimates for subcutaneous fat over the longissimus muscle approached 1.0 cm. Those not achieving this endpoint were harvested after being on trial for 197 d. Carcass data were collected following a 24-hr chill. No differences were observed for DM intake or carcass characteristics ($P > 0.05$). POS resulted in greater ($P < 0.05$) ADG in comparison to U and BM (1.77, 1.59, and 1.55 kg/d, respectively). Gain efficiency was improved ($P < 0.05$) for POS and BMU in comparison to U (20.04, 20.36, and 17.64 kg gain/100 kg DM, respectively). Experiment 2 evaluated the same treatments offered to 70 yearling steers (initial wt.=407 kg). Steers were blocked by weight to 12 pens with 5-6 animals per pen. Steers were implanted with an estrogenic implant. Cattle were offered dietary treatments for 100 d. Carcass data were collected following a 48-hr chill. Dietary treatments did not significantly ($P > 0.05$) alter any of the variables measured with ADG ranging from 1.79-2.17 kg/d and gain efficiencies of 18.00-20.08 kg gain/100kg DM. These data suggest

responses to reducing the dietary crude protein level by lowering the amount of supplemental degradable protein differs for calf-fed and yearling steers. Reducing dietary protein levels for short-fed yearling steers did not result in detrimental responses for performance or carcass traits. However, reducing dietary crude protein levels decreased ADG and lowered gain efficiency for calf-fed steers though carcass characteristics were not affected.

Key Words: Beef, Ruminant, Protein

T184 Responses of serum glucose, insulin, glucagon, and fatty acids to ruminal propionate and abomasal carbohydrates in Korean cattle. S. C. Lee¹, J. S. Eun², Y. K. Kim³, J. P. Cant⁴, and Y. H. Moon⁵, ¹National Livestock Research Institute, Suwon, Kyonggi, Korea, ²Samyang Feed Company, Suwon, Kyonggi, Korea, ³Chungnam National University, Taejon, Chung Nam, Korea, ⁴University of Guelph, Guelph, ON, Canada, ⁵RAIRC, Jinju National University, Jinju, Gyeong Nam, Korea.

The purpose of this study was to investigate responses of serum NEFA, glucose and insulin concentrations to different glucose sources. Two 4 x 4 Latin square experiments with periods of 8 d each were conducted. In experiment 1, four Korean steers (270 kg, 13 mo) were fed a ration of concentrate and rice straw at 80% of maintenance and treatments were 1 L of a 0, 0.5, 1.0 or 1.5 M propionate solution infused into the rumen between 1300 and 1400h each day for 5 consecutive days. On day 5, rumen and blood samples were collected during the infusion. Experiment 2 followed the same design with four Korean steers (304 kg, 20 mo), fed mixed hay at 1.5% of body weight, and infused abomasally between 1100 and 1800 h daily with water, or 30 g/h carbohydrate from glucose, corn starch or cane molasses. Blood samples were collected on day 6 of infusion. There was no effect of propionate dose on serum glucose or glucagon concentrations ($P > 0.05$). Insulin concentrations increased with dose ($P < 0.05$), peaking at 60 min of infusion at 20.7, 33.4, 42.4 and 53.8 mU/L for 0, 0.5, 1.0 and 1.5 M propionate, respectively. At 60 min, NEFA concentrations were reduced ($P < 0.05$) to 54, 76 and 57 μ M on 0.5, 1.0 and 1.5 M propionate, respectively, compared to 168 μ M with no propionate. Serum glucose concentrations were elevated ($P < 0.05$) during the first 100 min of abomasal infusion of glucose while starch and molasses had no effect compared to water. Serum insulin was increased and NEFA decreased by glucose infusion only. Serum glucagon was reduced ($P < 0.05$) from 78 to 53 mU/L by glucose infusion and to 64 mU/L by molasses but starch had no effect. In conclusion, propionate infusion increased insulin and decreased NEFA concentrations without affecting blood glucose level. The glycemic response to abomasal carbohydrates was greatest for glucose, intermediate for molasses and negligible for corn starch.

Key Words: Propionate Infusion, Carbohydrate Infusion, Blood Composition

T185 Hepatic mitochondrial efficiency of Angus and Wagyu heifers. J. J. Michal¹, J. J. Ramsey², K. A. Ross¹, D. E. Johnson³, and K. A. Johnson¹, ¹Washington State University, Pullman, ²University of California, Davis, ³Colorado State University, Fort Collins.

Mitochondrial proton leak kinetics were measured to explain variation in maintenance energy requirements (MEM) of two breeds of cattle. Ten-month old Angus (A) and Wagyu (W) heifers (N=8/breed) were fed a diet balanced for 0.13 Mcal NEm/kg<.75>. Liver biopsies were obtained with a Trucut biopsy needle, immediately placed in ice-cold isolation buffer with BSA, and homogenized within 30 min. Mitochondria were isolated and added (0.5 mg protein/ml) to respiration medium for simultaneous measurement of oxygen consumption and membrane potential at 37<o>C by an O₂ electrode and a TPMP+-sensitive electrode, respectively. Mitochondrial proton leak kinetics were determined by incremental additions of 0.3–10 mM malonate. Proton leak rate was calculated from respiration rate by assuming 6 protons are leaked per oxygen atom consumed. Open-circuit, indirect respiration calorimetry was used to determine heat production (HP) and MEM requirements. Angus and W heifers had identical HP (145.3 kcal/kg<.75>) and similar fasting HP (91.8 vs. 92.0 kcal/kg<.75>). There was no difference in MEM requirement between breeds, W (105.2 kcal/kg<.75>) and A (113.5 kcal/kg<.75>). Hepatic mitochondrial respiration rates were greater ($P < 0.05$) in A heifers than W (11.81 vs 7.52 nmol O/min/mg protein). Membrane potential was higher in mitochondria from W ($P < 0.001$) than

A (145.4 \pm 4.89 vs. 118.9 \pm 5.13 mV, respectively). At the same proton leak rate across all malonate levels, W mitochondria had greater membrane potentials ($P < 0.0001$) than A mitochondria. At a standardized membrane potential, A mitochondria had 2–2.5 fold higher proton leak rates than W mitochondria. Lower proton leak rates of W might indicate better efficiency of energy use than A; however, because of the large variation in proton leak rate and MEM within and across breeds, no apparent relationship to MEM was detected.

Key Words: Proton Leak, Efficiency, Oxygen Consumption

T186 Barley- versus protein supplemented corn-based diets for feedlot cattle evaluated using the NRC and CNCPS beef models. K. A. Beauchemin and K. M. Koenig*, Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada.

A study was conducted to evaluate the effects of supplementing a corn-based feedlot finishing diet with degradable intake protein in the form of urea or canola meal and urea on growth, intake and carcass characteristics. Animal performances were compared to those obtained by feeding a barley-based diet typical of diets fed commercially in western Canadian feedlots. Crossbred beef steers (288 steers, 435 kg initial BW) were allocated to 24 pens (12 steers/pen) and six pens were assigned to one of four diets: 1) barley grain (13.9% CP DM basis), 2) corn grain (10.0% CP, no protein supplementation), 3) corn grain with 1% urea (13.0% CP), and 4) corn grain with 6.4% canola meal and 0.3% urea (12.8% CP). Grains were steam-rolled and all diets contained 9% silage DM. Cattle were fed for ad libitum intake, weighed at 3-wk intervals, and slaughtered after 138 d on feed. There were no differences in ADG between cattle fed barley and those fed the corn diet supplemented to a concentration of CP similar to that supplied by the barley diet (1.40 vs 1.44 kg/d, SE 0.03; $P > 0.05$). However, ADG was 10% lower (1.29 kg/d; $P < 0.05$) and DM intake was 8% lower (8.97 vs 9.77 kg/d, SE 0.13; $P < 0.05$) for cattle fed the unsupplemented corn diet compared with that of cattle fed the other corn diets. Source of protein supplementation had no effect on ADG, but providing canola meal and urea improved feed efficiency by 7% compared with urea alone (6.35 vs 6.84 kg DM/kg gain, SE 0.09; $P < 0.05$). The NRC model (levels 1 and 2) and the CNCPS model predicted the substantially lower gain of cattle fed the unsupplemented corn diet, but only after intake was reduced to reflect the negative effects of ruminal N limitation on ruminal digestion and passage rate. Neither model predicted the improvement in feed:gain ratio observed when corn diets were supplemented with a combination of canola meal and urea rather than urea alone. Western Canadian feedlots can expect similar gain and feed efficiency from cattle fed steam-rolled barley or corn grain, provided that the corn diet is supplemented with canola meal and urea to supply at least 13% CP and 8% of dietary DM as degradable intake protein.

Key Words: Feedlot Cattle, Corn Grain, Protein

T187 Ruminal mucosa and epidermis morphology of calves infused with lactate, propionate or butyrate. S. F. Costa, M. N. Pereira*, L. Q. Melo, L. A.L. Muzzi, and M. L. Chaves, Universidade Federal de Lavras, Lavras, Brazil.

Volatile fatty acids may induce undesirable morphological changes on keratinized stratified epithelial tissues. We evaluated the effect of butyrate, propionate and lactate on rumen wall, the epidermis of the nasolabial surface, the *perioplum* and the *epicera* of calves. The adequacy of tegument biopsies as an indirect evaluator of the rumen mucosa was tested. Seventeen calves were fed exclusively on a whole fluid milk diet throughout the experiment. At 45 days of age Foley catheters were surgically placed into the rumen. Starting on day 52 until being slaughtered at 89 days of age, animals received twice a day infusions of saline or 0.0744 moles of propionate or butyrate per kg of BW^{0.75} daily or 0.0636 moles of lactate. All VFA induced greater increase on the weight of the rumen-reticulum than on omasum weight, butyrate was the VFA most stimulatory of organ mass. Abomasum mass was not affected by VFA infusion. Infusion of all VFA tended to increase the weight and proportion of mucosa in the cranial sac of the rumen, however they reduced papillae number per square centimeter of rumen wall. Only propionate tended to increase papillae area and height. The positive response to lactate and butyrate on mitosis of the basal cells of the epithelium apparently occurred in response to VFA induced rumenitis.

Histopathological lesions of the rumen wall were induced by VFA infusions. Butyrate and lactate were greater inducers of rumen epithelium pathological changes than propionate. The VFA increased hind *perio-plum* mitotic index and decreased mitosis on the nasolabial surface and *epicera*. The simultaneous effect of VFA on the morphology of ruminal mucosa and other keratinized tissues suggests that damage of hoof and ruminal epithelium, frequently reported on cattle subjected to ruminal acidosis, may have a common cause. Tegument biopsies may be useful as indicators of rumen mucosa morphology.

Key Words: Papillae, Rumen Wall, Volatile Fatty Acids

T188 Evaluation of quality, quantity and timing of colostrum feeding on immunoglobulin G1 absorption in jersey calves. E. C. Johnson, D. K. Kendall, and E. H. Jaster*, *California Polytechnic State University, San Luis Obispo.*

Twenty-four Jersey calves were randomly assigned to one of four treatment groups (6 calves per group). Pooled colostrum from first milkings (high IgG1 colostrum, 84 mg/ml) of multiparous cows was fed to treatment groups 1 and 2. Pooled colostrums from second and third milkings (low IgG1 colostrum, 31.2 mg/ml) of multiparous Jersey cows was fed to calves in treatment groups 3 and 4. The quality and timing of colostrum feeding was as follows: group 1, were fed (high IgG1 colostrum) 4 L at 0 hour (birth); group 2, calves were fed (high IgG1 colostrum) 2 L at 0 hour (birth) and 2 L at 12 hour; group 3, calves were fed (low IgG1 colostrum) 4 L at 0 hour (birth); and group 4 calves were fed (low IgG1 colostrum) 2 L at 0 hour (birth) and 2 L at 12 hour. Mean serum IgG1 at 48 h of age was 38.66, 45.66, 13.81 and 9.95 mg/ml in groups 1-4, respectively. Calves fed colostrum with higher concentrations of total ingested IgG1 (group 1 and 2) had significantly higher serum protein and IgG1 concentrations than calves fed low IgG1 colostrum at 48 h of age (group 1 and 2). Mean apparent efficiency (AEA) of IgG1 absorption was measured at 48 h and calves (group 2) receiving 2 L at birth and 2 L at 12 h of high IgG1 colostrum had higher mean apparent efficiency of IgG1 absorption than calves (group 4) fed 2 L of colostrum that was low in IgG1 at birth and 12 h (31.2% and 18.2% groups 2 and 4, respectively). Results suggest that dairy management practices support feeding Jersey calves two separate feedings of high quality colostrum to maximize the colostrum IgG1 intake.

Key Words: Colostrum, Immunoglobulin IgG1, Jersey calves

T189 Effect of time of milk replacer delivery on feed intake of calves during weaning. S. I. Kehoe*, M. L. Moody, and A. J. Heinrichs, *Pennsylvania State University, University Park.*

Recommended strategies for weaning calves attempt to reduce stress and also enhance feed intake. One common weaning method that provides this transition is to decrease milk feeding to once a day for one week. Effects of feeding frequency, feeding time, and diurnal patterns have been observed in mature cattle. However, diurnal patterns of feed intake have not been researched in preweaned calves. The objective of this study was to investigate feed intake of calves offered milk in the morning or in the afternoon. Forty two Holstein heifer calves were fed milk replacer at 10% bodyweight twice daily for 4 weeks (20% fat, 20% protein, Land OLakes, Arden Hills, MN). During the fifth week, milk was reduced to 5% of birth BW and fed once a day at 5 a.m. or 3 p.m. Calf starter (Startena, Purina, St. Louis, MO) and water were offered ad libitum and daily grain intake was monitored for 7 days, after which, calves were weaned. Statistical analysis consisted of mixed procedure of SAS 8.1 using calf nested within treatment as a random effect. Least squares means of grain intake for calves fed in the morning were 449.83 ± 75.47 grams and for calves fed in the afternoon were 455.01 ± 79.15 grams. Overall intake was not different between treatments ($P > 0.963$). There were also no significant differences between slopes of intake for either treatment over the 7-day period ($P > 0.409$). It is concluded that calves are not affected by milk replacer delivery time and consume calf starter equally whether fed milk as the morning meal or the afternoon meal.

Key Words: Calves, Feed Intake, Diurnal Effects

T190 Effects of dietary protein level and fish meal on growth and hormonal status of weaned dairy calves. P. T. Richardel*, C. C. Williams, H. G. Bateman, II, C. F. Hutchison, C. C. Stanley, Y. H. Chung, T. W. White, L. R. Gentry, D. L. Thompson, Jr., and D. T. Gantt, *LSU AgCenter, Baton Rouge, LA.*

Eight weaned Holstein calves approximately four months of age (mean BW = 119.47 ± 2.65 kg) were used in a replicated 4 x 4 Latin Square designed experiment to study the effects of protein source and level on performance of weaned dairy calves. Treatments consisted of two diets containing either 16 or 20% CP with or without fish meal. Experimental diets were corn-silage based, with soybean meal (SBM) as the source of ruminally degradable protein and fishmeal as a source of ruminally undegradable protein. The animals were fed their respective diets twice daily at ad libitum levels during each 10-day adjustment period and 4 day sample collection period. Animals were housed in individual stalls for 10 days and in metabolism crates for 4 days for each period. Total fecal and urine output were collected, weighed, and subsampled for laboratory analysis of nitrogen during the 4-day collection period. On day 4 of the collection period, animals were fitted with indwelling jugular catheters. Blood samples were collected at 15-minute intervals for 6 hours for analysis of growth hormone (GH) and at 30 minute intervals for analysis of insulin. On day 14 of each experimental period body weight, wither height, hip height, and body length were measured. Treatment did not affect ($P > 0.10$) dry matter intake. There were also no effects ($P > 0.10$) of protein level or source on nitrogen balance or on any of the growth parameters measured. Steers consuming diets containing 20% CP tended to have higher circulating concentrations of insulin ($P = 0.07$). Mean GH concentrations tended to be greater in steers fed SBM ($P = 0.07$), however the GH to insulin ratio did not differ ($P > 0.10$). These data suggest that feeding diets greater than 16% CP with or without fish meal does not improve performance in weaned dairy calves.

Key Words: Weaned Calves, Dietary Protein, Fish Meal

T191 Components of growth in Holstein heifers reared from early life on two levels of energy intake. M. J. Meyer*, D. A. Ross, D. E. Shaw, and M. E. Van Amburgh, *Cornell University, Ithaca, NY.*

The effect of two levels of energy intake initiated during the preweaning period, on composition of growth in Holstein heifers was determined in a slaughter study. Starting at 44kg, Holstein heifers ($n = 72$) were fed two levels of nutrient intake to achieve 650g (R) or 950g (E) daily gain. Six heifers were slaughtered at 46kg to establish baseline composition and treatment heifers were slaughtered every 50 kg from 100 to 350 kg. Preweaning live weight (LW), lifetime LW, and lifetime empty body (EB) weight gains were greater for E- than R-heifers (960 vs. 640g/d, 929 vs. 656g/d, and 717 vs. 491g/d, respectively, $P < 0.05$). At slaughter, heifers were separated into three components: carcass (CA); head, hide, feet and tail (HT); and blood and organs (BO). E- had more ether extract (EE) and less ash and crude protein (CP) per unit of EB weight than R-heifers ($P < 0.05$). Mean daily gains of EE, ash, and CP were all greater in E- than R-heifers ($P < 0.05$). Composition of daily EB gain was also influenced by diet as R- deposited more CP and ash but less EE per unit of EB gain than E-heifers ($P < 0.05$). Treatment effects on composition of EB gain were brought about by differences in rate of body component gain as well as changes in the composition of gain of these body components. Retention of total energy and EE energy per unit of EB weight was greater in E-heifers however retention of CP energy per unit of EB weight was higher in R-heifers ($P < 0.05$). Overall mean daily tissue energy (TE) retention was greatest in E-heifers ($P < 0.05$) reflecting the higher nutrient intake. Daily TE retained in protein ($y = 0.1621x + 0.0308$, $R^2 = 0.69$; $P < 0.05$) and EE ($y = 0.8379x - 0.308$, $R^2 = 0.98$; $P < 0.05$) as a function of total daily TE yielded equations that intersect at 0.91 Mcal/d total TE. Thus, daily retention of TE in excess of 0.91 Mcal/d will increase the proportion of TE that is deposited as EE than that deposited as CP, however, daily CP deposition will continue to increase. These data help describe nutrient requirements of the modern Holstein heifer.

Key Words: Heifer, Body Composition

T192 Urinary phosphorus and allantoin as parameters for rumen development in veal calves. A. M. van Vuuren*, N. Stockhofe, W. J. J. Gerrits, B. J. Suarez, and C. G. van Reenen, *Animal Sciences Group, Wageningen, Lelystad, The Netherlands.*

In the EU, allowance to solid feeds is prescribed for veal calves to stimulate their natural chewing behavior. However, for an optimal utilization of solid feeds, rumen fermentation is required. Allantoin (A) and phosphorus (P) in urine are potential parameters to estimate rumen development by non-invasive techniques. Urinary excretion of A is related to ruminal microbial biomass production. Urinary excretion of P is negatively related with ruminating activity. To validate the use of these parameters, 160 Holstein-Friesian male calves were allocated to 5 treatments, being milk replacer only (MILK) or milk replacer and in addition either beet pulp (PECT), soybean hulls and corn grits (NDF), corn and barley (STA), or a mix of all these ingredients (MIX). Eighty calves were slaughtered in wk 8, the remaining 80 calves in wk 12. By post-mortem examination, the development of rumen mucosa was classified as poor, moderate, or good. Urine (spot sample from each animal) was collected in wk 7 (n=160) and in wk 11 (n=80), and analyzed for A, P, and creatinin (C). No development of rumen mucosa was observed in animals receiving MILK. Less animals with poorly developed mucosa were observed when supplemented with PECT, NDF or MIX than when supplemented with STA. The P:C ratio in urine, sampled one week before slaughter, reflected the proportion of animals with poorly developed rumen mucosa. The A:C ratio was not related to rumen development. Probably, intake of fermentable OM and consequently synthesis of rumen biomass is too low to result in distinguishing amounts of allantoin in urine. It is concluded that the P:C ratio, but not the A:C ratio could be a tool to estimate rumen development in veal calves.

Effect of supplementation on rumen development and urinary components

	MILK	PECT	NDF	STA	MIX	S.E.M.
Animals with poorly developed mucosa ¹ , %	100 ^a	10 ^c	13 ^c	44 ^b	29 ^{bc}	
P:C ratio, mg/mmol	109 ^b	24 ^a	43 ^a	105 ^b	43 ^a	11
A:C ratio, mg/mmol	0.13	0.15	0.18	0.17	0.15	0.02

¹Fishers exact test ^{a,b}Figures with different superscripts in one row are significantly different (P < 0.05)

Key Words: Calves, Rumen, Urine

T193 Relationship of serum metabolites and insulin to beef marbling score in Korean cattle. J. S. Eun¹, S. C. Lee², Y. K. Kim³, and Y. H. Moon⁴, ¹Samyang Feed Company, Suwon, Kyonggi, Korea, ²National Livestock Research Institute, Suwon, Kyonggi, Korea, ³Chungnam National University, Tadjon, Chung Nam, Korea, ⁴RAIRC, Jinju National University, Jinju, Gyeong Nam, Korea.

Finding blood components exhibiting a significant relationship with meat quality, particularly marbling, in beef cattle will provide valuable information to optimize appropriate feeding strategies. This study was conducted to investigate changes in concentrations of serum metabolites and insulin during fattening and their relationship with final carcass characteristics in Korean cattle. Fourteen Korean steers (310±25 kg) were fed a ration of 12% CP and 72% TDN at 1.8% of body weight between 13 and 18 mo of age (phase 1) and a ration of 11% CP and 74% TDN ad libitum between 18 and 24 mo (phase 2). Throughout, steers had free access to rice straw, water and mineral block. Blood samples were collected bimonthly from a jugular vein 2 h after feeding (1100h) during the experiment. At 24 mo, steers were slaughtered following a 24 h fast. Carcass characteristics were evaluated from ribeye muscle at the cut surface between the 13th rib and the 1st vertebra. Means for each time point were separated by the Duncan's multiple range test. Concentrations of serum glucose were lower in phase 2 than in phase 1 (average 64.9 vs. 78.9 mg/dl). In contrast, serum NEFA concentrations were higher in phase 2 than in phase 1 (average 245 vs. 398 µeq/l). Serum insulin concentrations were elevated at 20 mo of age (27.5 µU/ml) compared to at 16 mo (20.2 µU/ml) and 24 mo (17.9 µU/ml) of age (P < 0.05). The Pearson correlation coefficients indicate that serum NEFA concentration was related to marbling score (see table below).

Items	Phase 1			Phase 2		
	Glucose	NEFA	Insulin	Glucose	NEFA	Insulin
Marbling score	-0.123	0.585*	0.215	-0.169	0.747**	0.342
Back fat thickness	0.278	-0.094	-0.123	-0.099	-0.572	-0.052
Longissimus muscle area	0.091	0.401	-0.199	0.254	0.004	0.122

*P < 0.05; ** P < 0.01

Key Words: Marbling Score, Korean Cattle, Serum Composition

T194 Using a DNA marbling marker, expected progeny differences, ultrasound, and live evaluation to predict carcass composition of early-weaned Simmental steers. C. B. Rincker*, N. A. Pyatt, L. L. Berger, and D. B. Faulkner, *University of Illinois, Urbana.*

Early-weaned Simmental steers (n = 175, Simmental or greater) of known genetics were individually fed over a four-year repeated trial to determine if a combination of aDNA marbling marker (GeneSTAR[®]), real-time ultrasound (RTU), EPDs, and live evaluation can accurately predict carcass composition. Steers were fed a high concentrate diet for 249.7 ± 0.7 d and harvested at 423.3 ± 1.4 d of age. RTU scans were recorded every 60 d for ribeye area (REA), intramuscular fat percentage (IMF%), and backfat (BF) with final scan taken < 13 d prior to harvest. Yearling weight (YW), marbling (MARB), percent retail cuts (PRC), and carcass weight (CW) EPDs were calculated for each steer. Visual animal evaluations were made at < 7 d to harvest by three evaluators to estimated quality (QG) and yield grade (YG). Five-year average price data were used for dressed beef, grid premium, and discounts. Gene marker frequencies did not affect marbling score (MS), chemical IMF%, QG, or percent low Choice or higher (P > 0.10). Live YG estimate was highly (P < 0.05) correlated to harvested BF (r = 0.23), and REA (r = 0.32); however, there was no relationship (P > 0.10) between live QG and MS. Genetic, live, and carcass parameters were regressed on chemical IMF, carcass value, and profit using step-wise regression analysis. With IMF%, 67.0% of the variation was explained by RTU QG (R² = 0.585), PRC (R² = 0.030), MARB (R² = 0.028), Live YG (R² = 0.017), and GeneSTAR Marbling Test (R² = 0.011) indicating that RTU was the only major contributor. Approximately 17% of the variation in average dressed price was explained by RTU QG (R² = 0.148) and MARB (R² = 0.025). GeneSTAR marbling marker was not an efficacious indicator for carcass composition of early-weaned Simmental steers. By using RTU, EPDs, and visual evaluation prior to harvest, producers can more accurately predict carcass composition.

Key Words: Carcass Value, Early-Weaned, Composition Estimation

T195 Fermentation characteristics and fatty acid biohydrogenation in continuous cultures of mixed ruminal microorganisms fed diets containing poultry products and nutrients reclaimed from the process water of processing plants. T. C. Jenkins*¹ and C. J. Sniffen², ¹Clemson University, Clemson, SC, ²Holderness, NH.

The process water from poultry processing plants contains considerable organic nutrients that must be captured, stored, treated, and disposed of in a manner that prevents environmental contamination. As an alternative, nutrients in the process water could be recycled as a feed supplement for ruminants. Because poultry process water has a high fat content containing unsaturated fatty acids, there is concern that it could inhibit ruminal fermentation, causing reduced feed digestibility. A novel process has recently been developed to reclaim nutrients from the process water by reacting organic matter to yield a dry, free-flowing product, which possibly may reduce or eliminate negative effects on fermentation. To test how lipids in the modified product were transformed by ruminal microorganisms, the feed ingredient, known as PRO*CAL, was incubated in continuous cultures and compared to two other fat sources. Four dual-flow continuous cultures were fed 30 g/d of forage and concentrate (1:1, DM basis). Concentrates contained no added fat or were supplemented (DM basis) with 5% PRO*CAL, 1.81% soybean oil (SBO), or 2.06% calcium salts of fatty acids (CAS). The four diets were fed to the fermentors in a 4 x 4 Latin square design with 10 d

periods. The cultures were adjusted to have a 0.10/d liquid dilution rate and averaged 84.0 mM total VFA concentration, 58.7% NDF digestibility, and 6.16 pH, which were not affected by diet. The acetate to propionate ratio was lowest for the SBO diet, highest for the CAS diet, and intermediate for PRO*CAL. Biohydrogenation of oleic, linoleic, and linolenic acids were lower ($P = 0.02$) for the PRO*CAL and CAS diets than for the SBO diet. Biohydrogenation of linolenic acid was lower for CAS than for PRO*CAL ($P = 0.07$). Based on the results of this study, PRO*CAL could be used as a dairy feed supplement without significant negative effects on ruminal fermentation, and as a means to increase the post-ruminal delivery of unsaturated fatty acids.

Key Words: Biohydrogenation, Fatty Acids, Poultry Products

T196 Effects of amino nitrogen on fermentation parameters by mixed ruminal microbes in batch and semi-continuous cultures when energy or nitrogen was limiting. H. Kajikawa^{*1}, A. Kawamura², K. Tajima¹, M. Mitsumori¹, and A. Takenaka¹, ¹National Institute of Livestock and Grassland Science, Tsukuba, Ibaraki, Japan, ²Tsukuba University, Tsukuba, Ibaraki, Japan.

Supplementation of amino N improves growth efficiency of and fermentation rate by ruminal microbes on purified nutrients, but these effects of amino N have not been always observed on actual feeding conditions of ordinary diets. The inconsistent effects may be attributable to the difference in the energy and N balance for the ruminal microbes since Van Kessel and Russell (J. Dairy Sci. 1996. 79:1237) showed that the growth of ruminal bacteria improved when the energy-excess batch cultures were provided with amino N. We prepared diet TC (Timothy hay:corn = 80:20 on DM basis) and TS (Timothy hay:soybean meal = 85:15 on DM basis), on which ruminal N balances were negative and positive, respectively, according to the model evaluations by the NRC (dairy cattle, 2001) and the CNCPS (ver.5, 2003) both, assuming that the diets were fed a mature cow at maintenance level. 1) Mixed ruminal bacteria were incubated in triplicate with diet TC or TS (100 mgDM/10 ml) in batch cultures in the presence of amino N (Trypticase) or ammonium N (70 mgN/L each). Gas production was slightly (by 6% or less), but significantly higher in the presence of amino N at 8 and 24 hr of incubation on both the diet, but no significant difference was shown at 48 hr between the N sources. 2) Mixed ruminal microbes were incubated with diet TC or TS (12 gDM/0.8 L/d) in semi-continuous cultures (Rusitec, eight vessels for each treatment) at 3.5 %/h of the dilution rate in the presence of amino N (Trypticase) or ammonium N (70 mgN/L each). There was no significant difference between the N sources on both the diets in any of the fermentation parameters (productions of total and methane gas, and total and each VFA) and microbial N yield, calculated from a sum of the nonammonia N in the effluent and N in the digested feed residues released by a neutral detergent treatment. More studies would be required to define the conditions on which the positive effect of amino N on microbial synthesis and fermentation in the rumen could be clearly exhibited on an actual dietary regimen.

Key Words: Amino Nitrogen, Rumen Fermentation, Microbial Synthesis

T197 Rumen microbial degradation of amino acids from fish meal and blood meal in continuous culture. S. Gargallo, S. Calsamiglia^{*}, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Eight dual flow continuous culture fermenters (1320 ml) were used in three 8-d replicated periods to study the effects of diets containing increasing levels of fish meal (FM) or blood meal (BM) on rumen microbial fermentation, nutrient flow and relative ruminal escape of dietary amino acids (AA). Fermenters were fed isonitrogenous diets composed of a basal mix (70.6% of total dry matter) and a protein supplement (29.4% of total dry matter). The protein supplement contained 0, 33, 66 or 100% of FM or BM, and a non-protein N source (urea and tryptone). Ruminal degradation of individual AA within protein supplement was calculated as the slope of the flow of each AA vs supplemental AA intake. Relative escape of individual AA was the ratio of ruminal escape of each AA vs average ruminal escape of total AA within supplemental protein. The inclusion of increasing levels of FM or BM to diets did not affect dry matter, organic matter and fibre digestion, total volatile fatty acids concentrations and molar proportions of individual volatile fatty acids. Ammonia N concentration and protein degradation decreased, and the flow of dietary N and AA increased with the increase of FM

or BM, without affecting microbial N flow and efficiency of microbial protein synthesis. Diets supplemented with BM provided the highest flows of essential AA and Lys, and those with FM provided the highest flows of Met. Relative ruminal escape of AA indicated that Ile was the most extensively degraded AA in BM, and Asp, Glu and Tyr were the most resistant AA in both protein sources. Results suggest that the resistance to rumen degradation of individual AA within a protein supplement differs, and the use of the AA profile of the original protein source may lead to inaccurate estimates of the supply of individual AA to the small intestine.

Key Words: Ruminal Degradation, Protein, Amino Acid

T198 Effects of time at suboptimal pH on rumen bacterial fermentation in a dual flow continuous culture system. M. Cerrato, S. Calsamiglia^{*}, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Seven 1325-ml dual flow continuous culture fermenters were used in three consecutive periods (8 days each) to study the effects of increasing time at suboptimal pH on rumen microbial fermentation and nutrient flow. Fermenters were maintained at 39C, with solid and liquid dilution rates of 5 and 10%/h, respectively, and fed 95 g/d of a 60 to 40 forage to concentrate diet (18.2% CP, 35.0% NDF). Treatments were a constant optimal pH (6.4) and 6 different intervals of time during the day at suboptimal pH (5.5) ranging from 4 to 24 h (in 4 h increases). Results were analyzed for linear (L), quadratic (Q) and cubic (C) effects ($P < 0.05$). Effects were L for total VFA (highest at constant pH 6.4 = 113.2 mM; lowest after 24 h at pH 5.5 = 83.5 mM) and acetate proportion (highest at constant pH 6.4 = 59.2%; lowest after 20 h at pH 5.5 = 44.8%). Effects were Q for propionate proportion (highest after 20 h at pH 5.5 = 43.4%; lowest at constant pH 6.4 = 18.5%), branch-chained VFA (highest at constant pH 6.4 = 4.4%; lowest after 20 and 24 h at pH 5.5 = 0.15 and 0.16 %, respectively) and acetate to propionate ratio (highest at constant pH 6.4 = 3.3; lowest after 20 and 24 h at pH 5.5 = 1.0 and 1.2, respectively). Effects were L for NDF digestion (highest at constant pH 6.4 = 50.5%; lowest after 24 h at pH 5.5 = 38.3%), ADF digestion (highest at constant pH 6.4 = 50.7%; lowest after 24 h at pH 5.5 = 32.2%) and ammonia N concentration (highest at constant pH 6.4 = 4.75 mg N/dL; lowest after 20 and 24 h at pH 5.5 = 2.9 and 3.1 mg N/dL, respectively). There were no effects of increasing time at suboptimal pH on protein degradation (mean = 47.1%), the flow of nonammonia N (mean = 2.8 g/d), dietary N (mean = 1.6 g/d) and bacterial N (mean = 1.28 g/d), and efficiency of microbial protein synthesis (mean = 32.72 g N/kg OM truly digested). Results indicate that increasing time at suboptimal pH may affect rumen microbial fermentation. Changes started to be significant after 8 h, and major changes were observed after 16 h at suboptimal pH.

Key Words: pH, Acidosis, Rumen Fermentation

T199 Effect of particle size on adhesion of Ruminococcus albus and ruminococcus flavefaciens to plant cell walls in vitro. Q. Meng^{*} and W. Gao, *China Agricultural University, Beijing, China.*

Two bacteria strains of Ruminococcus albus 7 and Ruminococcus flavefaciens FD-1 were used to study the effect of particle size on adhesion of cellulolytic ruminal bacteria to plant cell walls in vitro. Corn stalk cell walls were coarsely milled by hammer mill (CM, 1 mm) or finely milled by ball-mill (FM) for 48 h to produce two particle sizes of plant cell walls. Microcrystalline cellulose (MC) was used as a positive control. The adhesion was measured by culturing bacterial suspensions and corn stalk cell walls and microcrystalline cellulose at 39 C for 60 min, then centrifuging the mixtures at 150 x g for 5 min, and measuring the optical densities of the supernatant at 600 nm. The particle size had a significant influence ($P < .001$) on adhesion of three cellulolytic ruminal bacteria to the substrates. The adhesion percentages of FM, CM and MC were 80.3, 64.0 and 80.4% for R. albus ($P < .001$), and 72.9, 77.8 and 69.0% for R. flavefaciens ($P < .08$), respectively. The adhesion abilities of R. albus 7 and R. flavefaciens FD-1 to corn stalk cell walls were significantly declined after the treatment with periodate, LiCl, trypsin and protease ($P < .001$), indicating that certain proteinoous and carbohydrate molecules may be involved in the bacterial adhesion process. The bacterial adhesion inhibition to corn stalk cell walls was found in the use of monosaccharide of galactose at the concentration of 0.5% for R. albus 7 and 5% for R. flavefaciens FD-1, respectively. The inhibition effect of

methylcellulose on the adhesion of the two cellulolytic ruminal bacteria were only detected to CM both at the concentration of 0.05% and 0.1% ($P < .01$). On the basis of our experimental results, we concluded that glycoprotein associated with the bacterial cell surface of ruminococci may be responsible for the adhesion to plant cell walls.

Key Words: Adhesion, Cellulolytic Bacteria, Plant Cell Walls

T200 Effects of a blend of essential oils and the type of diet on rumen microbial fermentation and nutrient flow from a continuous culture system. L. Castillejos¹, S. Calsamiglia*¹, A. Ferret¹, and R. Losa², ¹Universitat Autònoma de Barcelona, Spain, ²AKZONOBEL/CRINA SA, Clond, Switzerland.

Eight dual flow continuous culture fermenters (1320 ml) were used in two consecutive periods of 8 d to study the effects of a specific blend of essential oils (EOB, CRINA RUMINANTS) on rumen microbial fermentation and nutrient flow. Temperature (39°C), pH (6.4), and liquid (10%/h) and solid (5%/h) dilution rates were maintained constant. Treatments were arranged in a 2 x 2 factorial design. Main factors were type of diet (diet 10:90, forage to concentrate ratio, 15.3% CP and 20.2% NDF; vs diet 60:40, forage to concentrate ratio, 18% CP and 30.2% NDF) and the addition of EOB (0 vs 1.5 mg/L of EOB). Diets (95 g/d of DM) were fed in three equal amounts along the day. Each experimental period consisted of 5 d of adaptation and 3 d of sampling. Effluent samples were taken from a composite of the three sampling days, and bacteria were isolated from fermenter flasks on the last day of each period for chemical analysis. Differences were declared at $P < 0.05$. There were no significant interactions between diet type and the addition of EOB. There were no effects of diet type on digestion of DM (average of 58.2%), OM (average of 58%), NDF (average of 40.6%), ADF (average of 46.7%) and CP (average of 36.8%). The 10:90 diet had a higher concentration of total VFA (128.1 vs 110.9 mM) and proportion of butyrate (18.5 vs 13.9 %) compared with the 60:40 diet. The 60:40 diet had a higher proportion of acetate (61.0 vs 50.3 %), acetate to propionate ratio (2.98 vs 1.98), ammonia N concentration (8.64 vs 3.01 mg/100ml), total N flow (3.57 vs 3.26 g/d), ammonia N flow (0.27 vs 0.10 g/d) and non-ammonia N flow (3.30 vs 3.17 g/d) compared with the 10:90 diet. There were no negative effects of EOB on DM, OM, NDF, ADF and CP digestion. The use of EOB increased the concentration of total VFA (122.8 vs 116.2 mM) without affecting individual VFA proportions or nitrogen metabolism.

Key Words: Essential Oil Blend, Rumen Microbial Fermentation

T201 Effects of different doses of plant extracts on rumen microbial fermentation. M. Busquet¹, S. Calsamiglia*¹, A. Ferret¹, and C. Kamel², ¹Universitat Autònoma de Barcelona, Bellaterra, Spain, ²University of Leeds, UK.

The effects of 4 different doses (3, 30, 300, and 3000 mg/L) of 18 plant extracts were evaluated in *in vitro* batch culture rumen microbial fermentations with a 50:50 forage to concentrate diet (17.3% CP; 28.0% NDF). Treatments were: control (C, no additive), plant extracts (fennel = FG, anise oil = AO, cade oil, cinnamon oil, clove bud oil, dill oil, garlic oil = GO, ginger oil, oregano oil, pepper oil, tea tree oil = TTO, and yucca = YU), and secondary plant metabolites (benzyl salicylate, anethol, carvacrol = CA, cinnamaldehyde = CI, eugenol, and d-carvone = DC). Raw materials were provided by AXISS France SAS (France). After 24 h, the pH was determined in culture fluid and samples were collected to analyse for ammonia N and volatile fatty acids (VFA). Differences were declared at $P < 0.05$. The highest doses (3000 mg/L) of most compounds resulted in higher pH and lower ammonia N and total VFA, suggesting that rumen fermentation was reduced, except FG and YU that resulted in lower pH and no decrease in total VFA. The FG (at 300 and 3000 mg/L) decreased the ammonia N concentration (-19 and -40 %, respectively) compared to C. The GO reduced the acetate (-10% at 300 mg/L; -9% at 3000 mg/L) and increased the propionate (+12% at 300 mg/L) compared with C. Anethol, AO, DC and TTO (at 3000 mg/L) reduced the proportion of acetate (-4, -4, -12 and -5 %, respectively) and propionate (-8, -8, -25 and -8 %, respectively) compared with C. Eugenol and CI (at 3000 mg/L) increased the propionate proportion (+9 and +9 %, respectively) compared with C. When dosed at 300 mg/L, CA reduced the acetate (-4%) and propionate (-7%) proportions, but when dosed at 3000 mg/L, it increased propionate proportions (+10%). Plant extracts may help modify rumen microbial fermentation,

but effects appear dose-dependent, and attention should be given to potential interactions and the subsequent effects on rumen fermentation and animal performance.

Key Words: Plant Extracts, Rumen Fermentation

T202 Ionized calcium requirements of cellulolytic ruminal bacteria for growth and cellulose degradation. M. S. Morales* and B. A. Dehority, OARDC, The Ohio State University, Wooster.

We investigated the ionized calcium (Ca^{+2}) requirements for growth and cellulose degradation of *Fibrobacter succinogenes*, strains A3c and S85; *Ruminococcus albus*, strain 7; and *Ruminococcus flavefaciens*, strains B34b and C94. Bacteria were grown in slants and transferred to a complete medium containing one-tenth the normal concentration of Ca^{+2} . After incubation overnight, the cultures were transferred to Ca^{+2} free medium and grown to an optical density (OD) between 0.6-0.7. Inoculum was prepared by diluting the culture to 0.1 OD with divalent cation-free medium, and 0.1 ml was used to inoculate each experimental tube. Medium containing 0, 0.02, 0.04, 0.08, 0.16, 0.32, 0.4 (Normal medium), 0.64 mM Ca^{+2} concentrations were tested. Growth was monitored by OD (660nm) in liquid cellobiose medium, and cellulose degradation was determined measuring cellulose residue after different times of incubation. Data were fitted mathematically to determine growth and degradation rates as well as concentrations required for maximum growth and extent of cellulose degradation. As Ca^{+2} concentrations increased, *F. succinogenes* S85 and A3c responded with increased maximum growth and growth rates, whereas these decreased for *R. flavefaciens* C94. Other strains were not affected by Ca^{+2} concentration. *F. succinogenes* A3c and S85 showed absolute requirements for Ca^{+2} for cellulose degradation, and rate and extent of cellulose degradation increased when Ca^{+2} concentration increased. For other strains, rate of degradation was not affected, although the extent of cellulose degradation tended to be higher with higher Ca^{+2} concentrations for *R. flavefaciens* C94 and B34b. *R. albus* 7 was not sensitive to Ca^{+2} concentrations, either in growth or cellulose degradation.

Key Words: Ruminal Bacteria, Cellulose Degradation, Ionized Calcium

T203 Empirical relationships between ruminal pH and volatile fatty acid concentrations. M. Devant¹, A. Bach*¹, and J. A. García³, ¹IRTA-Unitat de Remugants, Barcelona, Spain, ²ICREA, Barcelona, Spain, ³IRTA-Unitat de Química Alimentària, Girona, Spain.

The objective of this study was to establish empirical relationships between ruminal pH and total VFA concentrations and molar proportions. A total of 167 individual rumen samples from dairy cattle from two different dairy herds were obtained by rumenocentesis conducted every three weeks during the first 100 days of lactation 4 hours after offering the TMR. Rumen pH was measured immediately following sample extraction whereas samples for $\text{NH}_3\text{-N}$ and VFA determinations were frozen until subsequent analyses. The relationships between each factor and rumen pH were evaluated by regression analyses using the fit model procedure of JMP(r). Rumen pH was negatively related with acetate ($r = -0.35$; $P < 0.001$), propionate ($r = -0.51$; $P < 0.001$), butyrate ($r = -0.50$; $P < 0.001$), valerate ($r = -0.56$; $P < 0.001$), and total VFA ($r = -0.507$; $P < 0.001$) concentrations (mM). Despite the lower pKa of acetate compared with propionate, rumen pH was positively correlated with acetate ($r = 0.42$; $P < 0.001$) and negatively correlated with propionate ($r = -0.32$; $P < 0.001$) molar proportions (mol/100 mol). As total VFA concentrations increased, molar proportions of propionate increased linearly ($r = 0.22$; $P < 0.05$), whereas molar proportions of acetate and butyrate remained more constant. No linear relationship was found between rumen pH and $\text{NH}_3\text{-N}$ ($r^2 = 0.0007$; $P > 0.70$). The results from multiple regression analysis indicate that a model containing concentrations of acetate, propionate, isobutyrate, valerate, acetate to propionate ratio, and molar proportions of butyrate was able to account for about half of the observed variance in ruminal pH ($r^2 = 0.51$; $P < 0.001$; RMSE = 0.367). It is concluded that VFA concentrations and molar proportions can only account for half of the observed variation in ruminal pH, and thus, for modelling ruminal pH it is necessary to account for other factors such as ruminal buffer capacity and concentration of other organic acids, such as lactate and malate.

Key Words: Empirical, Rumen, Rumenocentesis

T204 An empirical analysis of ruminal microbial efficiency. E. Ungerfeld* and S. Rust, *Michigan State University, East Lansing.*

Since microbial protein synthesized in the rumen is a major source of amino acids for ruminants, it is important to understand microbial synthetic efficiency. A total of 111 treatment means of efficiency of microbial crude protein synthesis in the rumen (ME) from 29 published *in vitro* and *in vivo* trials was used for multivariate analysis to determine the relationships between ME and fermentation variables. Experiments were included as random factors in the model. Treatment means were weighted by the reciprocal of their variance (n/s^2) scaled to one. Microbial efficiency was 22.4 ± 7.89 (range 9.2 - 54.0) g microbial N/kg degraded OM. Total VFA concentration was linearly and positively related to ME, while isobutyrate to propionate (iB/P) and isovalerate to propionate (iV/P) ratios had quadratic relationships with ME. This model accounted for 94% of ME variation, although fermentation variables alone (i.e., without adjustment for experiment) explained only 2% of variation. A backward stepwise procedure ($P = 0.20$) without adjustments for experiments led to a model explaining 60% of ME variation that contained total VFA, butyrate to propionate (B/P, linear and quadratic), iB/P, valerate to propionate (V/P, linear and quadratic), iV/P (linear and quadratic) and pH (linear and quadratic). Hence, the inclusion of experiments in the first model accounted for a large portion of the variation in ME that could potentially be explained by fermentation variables but was experiment-associated. Total VFA could be an indicator of energy status, although VFA concentration does not necessarily reflect production. The decline in ME at high B/P could reflect high protozoal numbers and consequently, high bacterial lysis due to predation. Low ME at high V/P and iV/P could reflect inefficiencies associated to amino acids catabolism; however, there was a linear and positive response of ME to iB/P. The increase in ME at low pH was unexpected and did not reflect an association between pH and total VFA; low protozoal numbers at low pH are a possible explanation. Results suggest that fermented substrate and N recycling are important factors affecting ME, although much still needs to be understood.

Key Words: Rumen, Microbial Efficiency, Modeling

T205 *In vitro* synthesis of isopropanol from acetone by mixed rumen microbes. L. H. Rivier* and M. L. Bruss, *University of California, Davis.*

The objective was to assess the ability of mixed rumen microbes to convert acetone to isopropanol using ^{13}C -acetone *in vitro*. For this purpose, rumen fluid from four lactating and four dry, rumen-fistulated Holstein dairy cows was incubated with saline or 9.3 mmol/L $2\text{-}^{13}\text{C}$ -acetone for 0 or 8 hours and analyzed via gas chromatography and mass spectroscopy. There was negligible ^{13}C -isopropanol in the 0-hour incubates. In the 8-hour incubates, the isopropanol ^{13}C -atom percent averaged $32.5\% \pm 0.68\%$ (SE). The average transfer quotient (TQ = $100 \times$ atom percent of isopropanol/acetone) was $98.6\% \pm 2.3\%$ (SE). The atom percent and the TQ together demonstrate that all of the isopropanol detected in rumen fluid originated from the added acetone, which clearly indicates that rumen microbes are capable of directly converting acetone into isopropanol and that there is no other precursor. Other unidentified, non-acidic, unlabeled compounds were detected by gas chromatography. The average rate of synthesis of isopropanol from acetone was 2.46 ± 0.51 (SE) μmol per minute per liter of rumen fluid. There were no significant differences (t-test) between lactating and dry cows for any of the observed parameters. Isopropanol levels have been found to increase during ketosis and may be implicated in the nervous form of ketosis. Reducing equivalents generated from conversion of absorbed isopropanol back to acetone may contribute to the synthesis of glucose in the liver of ketotic cows.

Key Words: Acetone, Isopropanol, Rumen

T206 Site of digestion in dairy cows fed different soy-protein supplements. I. R. Ipharraguerre*¹, J. H. Clark¹, and D. E. Freeman², ¹*Department of Animal Sciences, University of Illinois, Urbana,* ²*Department of Veterinary Clinical Medicine, University of Illinois, Urbana.*

Four multiparous lactating Holstein cows cannulated in the rumen and duodenum averaging 209 DIM were used in a 4x4 Latin square design to evaluate the replacement of soybean meal (SBM) with soy-protein

products of reduced ruminal degradability. Diets contained 15% alfalfa silage, 25% corn silage, 34.3 to 36.9% corn grain, and 19.4% soy products; 18.2% CP, 25.5% NDF, and 35.3% starch (DM basis). In the experimental diets, SBM was replaced with expeller SBM (ESBM), non-enzimatically browned SBM (NSBM), or whole roasted soybeans (WRSB) to supply 10.2% of the dietary DM. Intakes (kg/d) of DM, OM, NDF, and starch were ($P > .05$) for SBM 19.8, 18.3, 4.8, and 6.9; for ESBM 21.4, 19.7, 5.4, and 7.7; for NSBM 20.9, 19.2, 5.2, and 7.4; and for WRSB 19.4, 18.0, 4.9, and 6.4. True ruminal digestion of OM and apparent digestion of NDF and starch in the rumen and total tract (kg/d) were ($P > .05$) for SBM 10.1, 2.4, 1.9, 4.0, and 6.7; for ESBM 10.1, 2.7, 2.4, 4.7, and 7.4; for NSBM 9.8, 2.5, 2.4, 4.2 and 7.1; and for WRSB 9.6, 2.6, 2.3, 4.0, and 6.2. Intake of N (SBM = 579, ESBM = 622, NSBM = 613, and WRSB = 567 g/d) and passage to duodenum of microbial N (SBM = 245, ESBM = 227, NSBM = 236, and WRSB = 209 g/d) were not affected by treatments ($P > .05$). Compared with SBM, the flow to duodenum (g/d) of nonammonia N (SBM = 467, ESBM = 514, NSBM = 564, and WRSB = 498) was higher ($P < .05$) for NSBM and that of nonammonia nonmicrobial N (SBM = 222, ESBM = 283, NSBM = 323, and WRSB = 289) was higher ($P < .05$) for NSBM and WRSB. Replacing SBM with ESBM tended to increase the ruminal outflow of both N fractions ($P < .09$ and $P < .08$, respectively). Among protected soy-protein supplements, ruminal escape of NAN was higher ($P < .05$) for NSBM than for WRSB (564 vs. 498 g/d). No differences were detected ($P > .05$) among treatments when the flow to duodenum of nonammonia nonmicrobial N (SBM = 48.4, ESBM = 56.0, NSBM = 58.5, and WRSB = 57.9%) and microbial N (SBM = 51.6, ESBM = 43.9, NSBM = 41.5, and WRSB = 42.1%) were expressed as percentage of N intake.

Key Words: Digestion, Rumen Undergradable Soy Protein, Dairy Cows

T207 Utilization of the mobile bag technique to determine intestinal digestibility of feedstuffs. S. K. Ivan*, H. L. Haugen, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

Our objective was to determine the effects of dietary wet corn gluten feed on intestinal digestibility of various feedstuffs. Two ruminally and duodenally fistulated steers (658 kg) were assigned randomly to a crossover design with 4-wk periods. Diets were formulated on a DM basis to consist of 12% alfalfa hay, 18% alfalfa haylage, 30% corn silage, 9% whole cottonseeds, and 31% concentrate or 38% wet corn gluten feed, 8.5% alfalfa hay, 10% alfalfa haylage, 19% corn silage, 5% whole cottonseeds, and 19% concentrate. A mobile bag technique was employed to determine the RUP, RUP digestibility, total tract digestible protein (TTDP), and total tract digestible DM (TTDD) of alfalfa hay, brome hay, alfalfa haylage, corn silage (CS), whole cottonseeds (WCS), soybean meal (SBM), non-enzymatically browned soybean meal (SP), and dried distillers grains (DDG). There was no consistent effect of diet on RUP, RUP digestibility, TTDP, or TTDD. The RUP (% of CP) ranged from 6.0% for alfalfa haylage to 75.7% for SP. The RUP digestibilities ranged from 15.3% for the alfalfa haylage to 96.5% for the SP. The RUP digestibilities for alfalfa hay (33.9%), brome hay (39.1%), alfalfa haylage (15.3%), and corn silage (19.2%) were lower than NRC reported values. The higher RUP digestibility of the SP sample is reflective of more total protein reaching the small intestine. The large range in RUP digestibility was not reflected in TTDP (% of CP) with corn silage being the lowest at 83.5% and SP the highest at 97.9%. The TTDD ranged from 53.0% for cottonseeds to 96.9% for SP. The total tract NDF digestibility of the forages ranged from 49.2% for the alfalfa haylage to 53.9% for the alfalfa hay. In this study, diet had little effect on intestinal digestibility of protein or DM. The higher the concentration of RUP reaching the small intestine the higher the RUP digestibility, leading to a smaller range in total tract CP digestibility compared with RUP digestibility.

Key Words: Mobile Bag, Wet Corn Gluten Feed, Intestinal Digestibility

T208 Effects of dietary sodium bicarbonate on ruminal and total tract digestibility of diet and diet components in dairy cows. C. S. Mooney* and M. S. Allen, *Michigan State University, East Lansing.*

Six ruminally and duodenally cannulated, mid-lactation (177 ± 12 DIM, mean \pm SD) Holstein cows were used in a replicated 3 x 3 Latin square design to evaluate effects of sodium bicarbonate on ruminal and total tract digestibility. Periods were 28 d in length with the last 14 days

for data and sample collection. Treatments were control, sodium bicarbonate at 1% of dietary DM and an isomolar concentration of sodium chloride. Diets were formulated to 20% forage NDF and 17.5% CP and contained a common base mix (95% of diet DM) to which treatment pre-mixes (5% of diet DM) were added. The control premix was composed of 50% finely ground dry corn and 50% ground rice hulls (DM basis). Sodium bicarbonate and sodium chloride were included in place of rice hulls in their respective pre-mixes. Fat-corrected milk (3.5%), DMI, and milk fat percentage were not affected by treatment and averaged 35.7 kg/d, 23.3 kg/d, and 3.51%. Liquid passage rate and valerate absorption rates were determined by analyzing disappearance curves of Co-EDTA and valerate from the rumen following a pulse dose. Duodenal flux of DM was measured using chromic oxide as a marker. Digestion and passage rates were determined using the ruminal pool and duodenal flux method. Treatments did not affect liquid passage rate or valerate absorption rate. Ruminal digestibility of DM, OM, NDF and starch were not affected by treatment. Passage rates of indigestible NDF and starch were not affected by treatment with means of 3.7 and 19.3 %/h, respectively. Digestion rates of potentially digestible NDF and starch were not affected by treatment with means of 2.0 and 19.8%/h. Furthermore, post-ruminal digestion and total tract of DM, OM, starch and NDF were not affected by treatment. These results do not support the hypothesis that sodium bicarbonate decreases ruminal starch digestibility by increasing passage from the rumen.

Key Words: Sodium Bicarbonate, Ruminal Digestibility, Passage Rate

T209 Ruminal characteristics and rate, site, and extent of digestion of dairy diets supplemented with canola fed to Holstein steers. S. E. Bedgar^{*1}, J. W. Schroeder¹, M. W. Chichlowski², M. L. Bauer¹, and S. A. Soto-Navarro¹, ¹North Dakota State University, Fargo, ²North Carolina State University, Raleigh.

Fifteen cannulated Holstein steers averaging 399 ± 21.7 kg initial body weight (BW) were assigned to treatments by BW to evaluate the effects of feeding ground canola seed (GCS) on site and extent of digestion and ruminal fermentation in a completely randomized design. Diets containing 0, 6.1, and 12.2% of the total ration dry matter (DM) as GCS were fed ad libitum for 33 d. Rations were formulated to represent high lactation diets that were isonitrogenous and equivalent to 1.74 Mcal of net energy per kg of DM. The control diet was composed of corn silage, ground ear corn, alfalfa, soybean, canola, and blood meal, vitamins, minerals, and chromic oxide as an external marker. Corn grain and canola meal were reduced as GCS (39.6% lipid) was added to the diets. Steers were acclimated to treatment for 25 d prior to collections. Duodenal and ileal samples were taken to represent every 1.5 h in a 12 h period from d 29 through 31. Total feces were collected from d 27 to 32, and rumen fluid samples were taken at 0, 2, 4, 6, 8, 10, and 12 h post-feeding on d 31. Inclusion of GCS did not affect intake or digestion of DM, organic matter (OM), fiber, and crude protein (CP). Ruminal pH and ammonia nitrogen were also similar among treatments. Concentration of ruminal volatile fatty acids (VFA) and butyrate decreased ($P < 0.01$), and propionate increased ($P < 0.01$) linearly with greater levels of GCS. Diets that contain 7% lipid with up to 4.2% added lipid from GCS, when fed to Holstein steers, did not affect the rate, site, or extent of digestion of DM, OM, fiber, and CP. These data suggest that canola can be used as an ingredient when formulating diets for high lactation dairy cows without negatively affecting digestion and ruminal fermentation.

Key Words: Canola, Digestibility, Dairy Steer

T210 Effect of a saponin-based surfactant on the processing characteristics and in vitro ruminal fermentation of barley grain. Y. Wang^{*} and T. A. McAllister, *Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, Canada.*

The effects of a saponin-based tempering agent (GrainPrep#8482) on barley grain were evaluated in two in vitro studies. In Exp. 1, barley grain was tempered at 20% moisture for 2 or 4 h. Surfactant was applied during tempering at 0, 60, 120, or 240 µL/kg DM, and the barley was processed with rollers set at a distance of 2.03, 2.22, or 2.41 mm, yielding a 4 × 3 factorial arrangement of treatments. Surfactant × roller distance interactive effects on barley processing were not observed ($P > 0.05$) at either tempering time. Applying surfactant did not affect ($P > 0.05$) the processing index (PI; vol wt after rolling/vol wt before rolling × 100%) or particle size distribution of the barley. Increasing the roller

spacing (from 2.03 to 2.41 mm) increased ($P < 0.05$) the PI and the proportion of particles sized 3.35 to 4.75 mm, but decreased ($P < 0.05$) particles >4.75 mm or <2.36 mm. In Exp. 2, barley grain was tempered for 2 h (20% moisture) with surfactant applied at 0 or 120 µL/kg DM, then processed with rollers set at 2.03 or 2.41 mm. The four preparations were incubated in buffered ruminal fluid with surfactant added at 0 or 360 µL/kg DM. Apparent IVDMD and gas production were higher ($P < 0.01$) with barley rolled at 2.03 mm than at 2.41 mm. Applying surfactant at 120 µL/kg during tempering and at 360 µL/kg prior to incubation reduced ($P < 0.05$) IVDMD and the accumulation of VFA and reducing sugars, irrespective of roller setting. When rollers were set at 2.03 mm, adding surfactant during tempering, prior to incubation, or at both times reduced ($P < 0.05$) the acetate:propionate ratio after 4 h of incubation. However, this effect was observed only with the highest dose (120 + 360 µL/kg DM) of surfactant and a roller setting of 2.41 mm. The surfactant exerted no substantial effect on the processing characteristics of barley grain, but it did reduce the initial rate, but not the extent, of IVDMD from processed grain.

Key Words: Barley Tempering, Ruminal Fermentation, Surfactant

T211 Development of an in vitro technique to determine intestinal digestion of protein supplements by a Daisy II incubator. S. Gargallo, S. Calsamiglia^{*}, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

A Daisy II incubator was used to develop an in vitro technique to estimate intestinal digestion of proteins and amino acids (AA). The objective was to adapt the three step in vitro procedure (TSP; J. Anim. Sci. 1995. 73:1459-1465) to reduce the cost and labor involved in the determination of intestinal digestion of proteins, and to obtain a residue that could be analyzed for AA content. Four tests were conducted to study the effects of the type of pepsin (Sigma P-7012 vs Sigma P-7000), the type of bags used for the incubation of samples (nylon bags, Ankom R510, vs bags for fiber analysis, Ankom F57), the amount of sample per bag (0.5, 1, 2 or 5g) and the number of bags per incubation bottle (5, 15, 20 or 30 bags) on the estimated intestinal digestion of protein. A soybean meal (SBM) sample heated at 170°C for 0, 0.5, 1, 2, 4, 6 and 8h was used in all preliminary tests to determine the optimum conditions of the technique. The intestinal digestion of 12 protein supplements was determined using the proposed DaisyII and the TSP techniques. Results using the two types of pepsin were strongly correlated ($r = 0.99$; $P < 0.0001$), indicating that the use of the cheapest (Sigma P-7000) did not affect the results. Intestinal digestion values of the SBM samples obtained from the TSP assay were highly correlated with those obtained using the DaisyII incubator with both types of bag ($r = 0.99$; $P < 0.0001$), and with an amount of sample from 0.5 to 5 g ($r = 0.99$; $P < 0.0001$). The number of bags per incubation bottle did not affect ($P > 0.10$) intestinal digestion values determined with the DaisyII incubator. Intestinal digestion values of the 12 protein supplements determined with TSP and with DaisyII technique were highly correlated ($r = 0.92$; $P < 0.0001$). These results indicate that the use of up to 30 nylon bags (Ankom R510) with 5 g of sample in each DaisyII incubation bottle could be used to estimate intestinal digestion of protein supplements.

Key Words: In Vitro, Intestinal Digestion, Protein

T212 The in vitro digestibility, gas production and fermentation characteristics of *Mucuna pruriens*, and soybean meal treated with or without L-Dopa. A. T. Adesogan^{*}, S. K. Chikagwa-Malunga, M. B. Salawu, and S. C. Kim, *University of Florida, Gainesville.*

Mucuna pruriens (velvet bean) seeds contain 25-35% CP, but concerns about possible antinutritive effects of their L-Dopa (5-6% DM), have limited their use in ruminant diets. A 3 × 6 factorial design was used to determine the rumen fermentability of *Mucuna*, seeds (M) and soybean meal treated with (SBD) or without (SB) L-Dopa (138g/kg DM). Ground (1mm) substrates were incubated in triplicate at 38°C in 9 ml media and 1 ml rumen fluid for a series of six, 48 h, consecutive batch cultures. The first culture was inoculated with rumen fluid from 2 cows fed hay and soybean meal. Subsequent cultures were inoculated with fluid from the previous culture. After each culture, gas production was measured from syringes placed in the culture tubes, in vitro DM digestibility was calculated and fermentation acids were analyzed by high performance liquid chromatography. DM digestibility (g/kg) and gas production (ml) from M were higher ($P < 0.001$) than from SB and SBD,

616 v 540, 554 and 3.7 vs. 3.2, 3.1 respectively. There were no differences ($P>0.05$) between SB and SBD in DM digestibility and gas production, suggesting that L-Dopa addition did not depress the extent of fermentation of SB. Over the sequence of cultures, DMD of M and SB were decreased ($P<0.05$) linearly and cubically respectively, but DMD remained unchanged in SBD. Whereas, gas production increased ($P<0.05$) linearly, quadratically, and cubically in M, SB and SBD respectively. Over the sequence of cultures, acetate levels were unchanged in SB, but they increased ($P<0.05$) quadratically and cubically in SBD and M respectively; propionate levels were unchanged in SBD but they increased ($P<0.05$) cubically and quadratically in M and SB respectively; and butyrate levels were unchanged in M, but they increased ($P<0.05$) linearly in SB and SBD. In conclusion, M seeds are readily fermentable in the rumen. Adding L-Dopa to SB, did not affect the extent of digestion or gas production, but changed the fermentation acid profile.

T213 Estimated dry matter, crude protein and neutral detergent fiber degradation of some feeds by in situ technique. L. Cabral^{*1}, S. Valadares Filho², J. Zervoudakis¹, A. Souza¹, and E. Detmann³, ¹Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa, DZER-FAMEV/UFMT, Cuiabá-MT, Brazil, ²Universidade Federal de Viçosa Av. P.H. Rolfs, Viçosa-MG, Brazil, ³Universidade Estadual do Norte Fluminense CCTA, Campos Dos Goytacazes - RJ, Brazil.

The present work aimed to determine the degradation kinetic parameters of the dry matter (DM), crude protein (CP) and neutral detergent fiber (NDF) for corn silage, elephant-grass silage, Tifton-85 bermudagrass hay and soybean meal. Three rumen cannulated cattle were used (avg 400 kg body weight), in a 3x3 latin square. The feeds were weighed in nylon bags (10-20 mg/cm²) and incubated all in one time. Bags were removed 0, 2, 4, 8, 16, 24, 48 and 72 hours after of incubation for roughages, and 0, 2, 4, 8, 16, 24 and 48 hours for soybean meal. The residues in the bags were analyzed for residual dry matter, crude protein and NDF on each time and the degradation curves were adjusted using non linear models, where for DM and CP a first order assintotic model was used and for NDF a sigmoidal model was used. The data were analyzed by analysis of variance using SNK tests, calculating the average values of parameters and respective coefficients of variation (CV). The soybean meal and corn silage presented potentially digestible fraction for dry matter of 99.8% (CV = 3.02%) and 83.88% (CV = 3.22%) and potentially digestible fraction for the crude protein of 99.85% (CV = 5.74%) and 89.39% (CV = 6.92%), respectively. The soybean meal and corn silage had degradation rates for the crude protein of 0.1368 h⁻¹ (CV= 6.14%) and 0.0756h⁻¹ (CV = 7.98%), respectively. The Tifton-85 bermudagrass hay had indigestible NDF fraction of 40.89% (CV =6.28%), that affected the dry matter degradation, have been observed value of 61.9% (CV = 4.77%). The estimative of the kinetic parameters by in situ technique was a good predictor of the nutritive value of the feeds evaluated.

Key Words: Degradation Rate, Indigestible NDF, Kinetic Parameters

T214 Effect of freeze drying versus oven drying on dry matter and starch digestibility of corn mutants with Oh43 inbred line background harvested at four growth stages. D. Ngonyamo-Majee¹, R. D. Shaver¹, D. Sapienza^{*2}, J. G. Coors³, J. G. Lauer³, and C. Venhaus², ¹Dairy Science Dept., University of Wisconsin, Madison, ²Pioneer Hi-Bred Int'l Inc., Johnston, IA, ³Agronomy Dept., University of Wisconsin, Madison.

Combined effects of single gene mutations, harvest stage (HS), and sample drying technique (DT) on the proportion of corn dry matter (DM) and starch digested ruminally and post-ruminally was evaluated using four near-isogenic lines in Oh43 inbred background (*fl*, *o2*, *su2* genes and straight OH43). The inbred lines were grown at University of Wisconsin, West Madison Research Station during the summer of 2002 in 3*5m row plots in a randomized complete block design with three replications. The inbreds were harvested at four HS (HS1=1/2 milk-line; HS2=5d post HS1; HS3=10d post HS1; and HS4=black layer stage or about 15d post HS1) and samples were split in two for oven drying (OD) at 40°C for 72 hrs and freeze drying (FD) treatments. Dried kernels were ground through a Wiley mill (6 mm screen, Arthur H. Thomas, Philadelphia, PA) for measurement of ruminal in situ dry matter (RDMD) and starch digestion (RSTARCD) at 0 and 14-hr incubation (1.5g/bag x 8 replicates per time point per steer in 5x5cm bags of 50µm pore size) using two steers. Residue from the 14-hr bags proceeded

to an 8-hr enzymatic post-ruminal digestion (Pioneer Hi-bred Int.), from which the post-ruminal residue was oven dried at 62°C for 24 hours and DM and starch contents determined. Inbred by DT interactions were observed for zero-bag losses ($p<0.0001$), RDMD ($p=0.0024$) and total DMD ($p=0.0089$). Harvest stage by DT interactions were observed for bag losses ($p<0.0001$), RDMD ($p=0.0031$) and total DMD ($p=0.0551$). Inbred by HS interactions were observed for bag losses only ($p=0.0208$). Freeze dried samples were more highly degraded than OD samples, especially for earlier harvested samples (HS1 and HS2), 0-hr losses, and RDMD versus TDMD. The ranking of inbreds for decreasing RDMD and TDMD was *o2*(Oh43)>*fl2*(Oh43)=*su2*(Oh43)>Oh43. When compared to FD, OD corn samples at 40°C reduced 0-hour DM loss through bag pores, particularly for early harvested samples.

Key Words: Corn Mutants, Starch Digestibility, Drying Technique

T215 Effect of kernel vitreousness on ruminal and total tract dry matter digestibility of diverse corn germplasm sources. D. Ngonyamo-Majee¹, R. D. Shaver^{*1}, J. G. Coors², D. Sapienza³, J. G. Lauer², and C. Venhaus³, ¹Dairy Science Dept., University of Wisconsin, Madison, ²Agronomy Dept., University of Wisconsin, Madison, ³Pioneer Hi-Bred Int'l Inc., Johnston, IA.

Correlations between kernel vitreousness (V) and ruminal (RDMD) and total tract dry matter digestibility (TDMD) were evaluated using 33 germplasm sources selected for future development of corn hybrids for starch digestibility. Germplasm sources included 17 lines from the Germplasm Enhancement of Maize project at Iowa State University, 6 flint lines from North Carolina State University and the International Maize and Wheat Improvement Center (CIMMYT), 6 near-isogenic inbreds of Oh43 carrying *o2*, *fl2*, *su2*, *ae1*, *h1* and *wx1su2* alleles affecting endosperm composition, an experimental breeding population (WQS C2), and three check inbreds (B73, Oh43, and W64A). Inbreds were harvested at two growth stages; 1/2 milk-line (ML) and black-layer (BL). Kernels from middle portion of ears were oven dried at 40°C for 72 hrs and ground through a Wiley mill (6 mm screen Arthur H. Thomas, Philadelphia, PA) for measurement of in-situ RDMD after 0 and 14 hr of incubation (1.5g/bag x 8 replicates per time point per steer in 5x5cm bags of 50µm pore size) using two steers. Residue from the 14-hr bags proceeded to an 8-hr in vitro enzymatic post-ruminal digestion (Pioneer Hi-bred Int.) from which the residue was oven dried at 62°C for 24 hours and DM content determined. Inbred by harvesting stage interactions were observed for 0-hr disappearance ($P<0.0001$) and TDMD ($P=0.0066$). Vitreousness of the 33 germplasm, determined by near infrared reflectance spectroscopy (NIRS) in a previous study, was better correlated to DMD at BL stage ($R^2=0.66$; 0.52; and 0.36) than ML ($R^2=0.38$; 0.44; and 0.14) for RDMD, 0-hr disappearance and TDMD, respectively. Inbreds *su2*(Oh43) and *wx1su2*(Oh43) were outliers with high %V and also high RDMD. Their removal from the regression improved R^2 values for both harvesting stages (BL= 0.81, 0.54, and 0.46; ML= 0.72, 0.50 and 0.34) for RDMD, 0-hr disappearance and TDMD, respectively. This suggests that endosperm characteristics other than V may affect corn digestibility.

Key Words: Corn, Digestion, Vitreousness

T216 Fines in steam-flaked corn samples disrupt the relationship between flake density and gelatinized starch content. D. R. Brown^{*1} and M. K. Meilahn², ¹Agland, Inc., Eaton, CO, ²Weld Laboratories, Inc., Greeley, CO.

The relationship between flake density and gelatinized starch has been well documented under research conditions but not under field conditions. The objective of this study was to evaluate the relationship between flake density and starch gelatinization in steam-flaked corn samples received from feed manufacturers across a wide geographic region. Flake density, gelatinized starch, and fines content were determined in approximately 300 flaked corn samples from mainly the western United States and some from central Canada. Samples were received by a commercial laboratory, split, dried at 100°C for 24 h or 65°C for 48 h, and ground through a 2 mm screen using a Wiley mill and then ground to pass a 1mm screen using a udy cyclone mill. Gelatinized starch was measured using the method described by Meilahn and Brown (2003). Intact retention samples were grouped into three categories based on their fines content. Category one samples contained low levels of fines, category two had moderate levels, and category three had high levels of fines. Each fines-category contained flakes weighing from approximately

23 to 35 lb/bu. Data were analyzed using the regression and GLM procedures of Minitab (1996). Flake density across all samples averaged 31 ± 7.3 lb/bu and ranged from 22 to 42 lb/bu. The level of gelatinized starch across all samples averaged 660 ± 22 lb/ton of flaked grain (DMb) and ranged from 300 to 1100 lb/ton of flaked grain (DMb). Flake density increased slightly with increasing fines score ($P < 0.001$) but was highly variable ($r^2 = 6.2\%$). Gelatinized starch content decreased with increasing flake density and fines score ($P < 0.001$) but was highly variable ($r^2 = 15.5\%$). The regression equation was: gelatinized starch lb/ton of flaked grain (DMb) = $1145 - 61.3(\text{fines score}) - 11.9(\text{flake density})$. Fines score accounted for 65% and flake density 35% of the explained variation in gelatinized starch. These findings indicate the use of flake density as a reliable proxy for starch gelatinization (and availability) or digestion is erroneous when using samples derived from feed manufacturers across a wide geographic area.

Key Words: Steam-Flaked Corn, Gelatinization, Starch Availability

T217 Effect of dietary forage source and crude protein level on in vitro microbial protein synthesis and ruminal fermentation. J. J. Olmos Colmenero*¹ and G. A. Broderick², ¹University of Wisconsin, Madison, ²U.S. Dairy Forage Research Center, Madison, WI.

Optimizing microbial protein synthesis in the rumen is crucial because it represents more than half of the NAN that reaches the duodenum in dairy cows. A 3x5 factorial arrangement of 15 diets, three forage sources [alfalfa silage (AS); 50% alfalfa silage:50% corn silage (AS:CS); corn silage (CS)] at each of 5 CP levels (13.5, 15.0, 16.5, 18.0, and 19.5% of DM) were tested in two identical ruminal in vitro incubations. Diets contained (% of DM) 50% forage and 50% concentrate. High moisture corn was replaced with solvent soybean meal to increase CP. The marker used for microbial NAN synthesis (MNS) was ¹⁵N. After 4 and 8 h of incubation, samples were taken to obtain total solid pellets, supernatants, and isolated bacterial pellets. Supernatants were analyzed for NH₃, total AA, and VFA. Total solid and bacterial pellets were analyzed for DM, total N and ¹⁵N to estimate true dry matter digestibility (TDMD) and net MNS (i.e., blank corrected). Concentration of total AA, acetate, and total VFA were higher for AS and AS:CS compared with CS. However, propionate concentration and TDMD were higher on AS:CS than on AS and CS. Net MNS was higher on CS than on AS and AS:CS. Levels of dietary CP affected only NH₃ and total AA concentrations. As expected, NH₃ and total AA increased with dietary CP content. Under the conditions of this study CS was more effective for stimulating net MNS than AS and AS:CS; CP level had no effect on net MNS.

Item	Forage				SE	P>F	
	AS	AS:CS	CS	CP, % of DM			
NH ₃ , mM	1.90	1.85	1.98	0.04	0.06		
Total AA, mM	3.01 ^a	2.96 ^a	2.21 ^b	0.15	<0.01		
Acetate, mM	62.2 ^a	62.3 ^a	57.5 ^b	3.3	<0.01		
Propionate, mM	26.1 ^b	27.6 ^a	26.5 ^b	0.7	<0.01		
Total VFA, mM	102 ^a	104 ^a	98 ^b	4.6	<0.01		
TDMD, %	55.9 ^b	57.9 ^a	55.5 ^b	1.5	0.02		
Net MNS, mg/g of TDMD	30.0 ^b	30.8 ^b	34.8 ^a	0.5	<0.01		
Item	13.5	15.0	16.5	18.0	19.5	SE	P>F
NH ₃ , mM	1.50 ^e	1.74 ^d	1.91 ^c	2.10 ^b	2.31 ^a	0.05	<0.01
Total AA, mM	2.57 ^c	2.71 ^b	2.75 ^{ab}	2.77 ^{ab}	2.84 ^a	0.15	<0.01
TDMD, %	55.5	56.7	56.8	55.9	57.2	1.0	0.61
Net MNS, mg/g of TDMD	31.2	31.8	32.0	32.1	32.0	0.6	0.81

Key Words: In Vitro, Microbial Nitrogen Synthesis

T218 Forage mixtures to increase N-use efficiency by lactating dairy cows. R. J. Dewhurst*, L. J. Harris, and R. T. Evans, Institute of Grassland and Environmental Research, Aberystwyth, UK.

Earlier studies with white clover silage (WCS) showed increased milk production in comparison with grass silage (GS) and suggested that this may be related to high intake characteristics and/or high rumen passage rates. WCS is a high-protein forage crop (30% CP) and possible improvements in N-use efficiency that relate to inherent properties of WCS could only be achieved using mixtures with complementary low-protein forages- such as corn silage (CS). Eight multiparous Holsteins (initially in month 3 of lactation; initial BW = 640 kg) were used in a N partitioning study with three 4-wk periods. Total collections of milk, urine and feces were made in the final 6 d of each period. All cows received 8 kg/d of a standard dairy concentrate (19.9% CP in DM) and had *ad libitum* access to one of 4 forage treatments: GS, GS/CS (60/40 on a DM basis), WCS/CS (20/80 on a DM basis), and WCS/CS (40/60 on a DM basis). Diet CP contents were 18.6, 16.9, 15.2, and 17.5 % of DM respectively. WCS/CS diets led to increased DM intake (16.6, 18.1, 21.8, and 21.8 kg/d respectively; SE = 0.38; $P < 0.001$), milk yield (30.1, 30.3, 32.5, 31.7 kg/d respectively; SE = 0.50; $P < 0.05$) and milk protein % (3.03, 3.09, 3.17, and 3.25 % respectively; SE = 0.037; $P < 0.01$). Milk fat % was unaffected (mean = 4.20%). Urine output was reduced for the diets with lower N content (32.5, 26.2, 20.4, and 23.7 kg/d respectively; SE = 0.51; $P < 0.001$). Urinary N output decreased (177, 136, 118, and 146 g/d respectively; SE = 9.0; $P < 0.001$), whilst milk N yields increased (141, 145, 160, and 161 g/d respectively; SE = 2.8; $P < 0.001$). This led to a 41% increase in milk N output per g of urinary N. Urinary excretion of purine derivatives (allantoin plus uric acid; an index of rumen microbial yield) was highest for GS (37.2, 28.5, 25.2, and 30.2 mmol per kg DM intake respectively; SE = 2.01; $P < 0.001$). Consequently, it seems more likely that the improvements in N-use efficiency are the result of improving the balance of energy and protein supply to the cow than of increased rumen efficiency.

Key Words: Dairy Cow, Nitrogen Efficiency, Forage

T219 Impact of rumen protected lysine and methionine sources on yield of milk and milk components: a statistical survey of published literature. L. M. Rode*¹ and M. Vazquez-Anon², ¹Sage Biosciences Inc., Lethbridge, AB, Canada, ²Novus International, Inc., St. Charles, MO.

It is generally recognized that providing ruminally protected lysine (RPLys) and methionine (RPMet) in optimal amounts and ratios will maximize milk protein yield (NRC 2001). It is less clear what impact RPLys and RPMet supplementation has on milk volume and milk fat yield. A database of published literature was established to investigate the impact of rumen protected Lys and Met sources on yield of milk and milk components. Information from 66 diets was obtained from published literature in which RPLys (n=10), RPMet (n=21), and RPLys plus RPMet (n=35) were fed to lactating dairy cows. Results were compiled for milk yield, milk fat and protein yield and percent and expressed as absolute amounts or as a percent response relative to controls. Results were ranked according to the milk protein yield response, as a percent of controls. Studies were subdivided into two groups: lower 50 percentile (No/Low response; LOW) and upper 50 percentile (High response; HIGH). Percentage response for yields of milk, protein and fat and percentages of protein and fat were respectively 2.9 ± 2.4 , 3.8 ± 5.1 , -1.4 ± 3.8 , 0.4 ± 3.6 , -4.2 ± 4.4 for RPLys; -0.2 ± 3.0 , 2.2 ± 3.3 , 1.9 ± 4.1 , 2.6 ± 2.6 , 2.3 ± 3.3 for RPMet and 2.1 ± 4.3 , 4.8 ± 5.5 , 4.5 ± 6.9 , 2.6 ± 2.0 , 2.3 ± 3.5 for RPLys plus RPMet. For HIGH responses, RPLys increased milk and protein yield by 4.6 ± 1.2 and 7.7 ± 4.2 percent and decreased milk fat percentage by 6.6 ± 4.5 percent whereas RPMet increased milk yield, protein yield and milk fat percentage by 1.9 ± 1.9 , 4.9 ± 2.0 and 2.0 ± 2.5 respectively. Supplementing with RPLys tends to increase yield of milk and milk protein while decreasing yield and percentage of milk fat. Supplementing with RPMet tends to increase milk and protein yield as well as milk fat percentage. Results for RPLys plus RPMet were similar to RPMet alone.

Key Words: Lysine, Methionine, Rumen Bypass

T220 Effects of DL-methionine and lysine HCl on fermentation in vitro. T. W. Braud*, H. G. Bateman, II, C. C. Williams, and D. T. Gantt, *LSU AgCenter, Baton Rouge, LA.*

Previous experiments from our laboratory indicated that supplemental DL-met and lys- HCl enhanced ruminal fermentation in vitro. However, treatments in the previous study were not isonitrogenous. Therefore an experiment was conducted to determine if the enhancement was due to the added amino acids or the presence of a readily fermentable N source. Single effluent fermentors were used to determine if supplying DL-met and lys-HCl in the substrate would enhance microbial fermentation. Corn silage was dried at 55 C and ground to pass a 2 mm screen and used as the basal substrate for the fermentations. Treatments were a 2 x 2 factorial arrangement of DL-met (0 or 0.5% of DM) and lys-HCL (0 or 1% of DM). Treatments were made isonitrogenous by adding L-gln. Fermentations were conducted over a 5 d period with the final day used for sampling. Fermentor pH was maintained at 6.0 or greater by infusion of equal volumes of 0.5 M NaH₂PO₄ and NaHCO₃. Due to formulation errors, added lys resulted in decreased (P < 0.05) N, increased (P < 0.01), DM, and a tendency (P < 0.1) for decreased OM in the treatments. Total volume of effluent was not affected by treatment. Concentrations of total VFA were not affected by treatment. The proportion of propionate tended (P < 0.1) to increase when lys was added but there was no effect on the ratio of acetate to propionate. There was an interaction of met and lys for the proportion of isobutyrate (P < 0.01). Adding lys without adding met decreased the proportion of isobutyrate while the proportion increased when lys and met were added. No other proportions of VFA were affected by treatments. Ammonia concentrations were decreased (P < 0.05) by added met but were not affected by lys. Free amino acid concentrations in the effluent tended (P < 0.1) to decrease when met was added but were not affected by lys. Peptide concentrations were not affected by treatment. These data indicate that adding DL-met and lys-HCl may enhance fermentation in vitro. However, the effects are small and may not elicit a response when translated to in vivo practices.

Key Words: Rumen, Amino Acid, Fermentation

T221 Determination of undegradability and ruminal effects of HMB, HMBi, and DL-MET in lactating cows. S. Noftsker*, N. R. St-Pierre, and J. L. Firkins, *The Ohio State University, Columbus.*

The effects of Met provided as HMB, HMBi, and dl-Met were examined. Eight cows were used in a replicated 4 X 4 Latin square design. Effects on milk composition and yield, N utilization, VFA, and protozoa were determined. Samples of omasal fluid were used to determine the amount of Met supplements passing out of the rumen. Treatments were: (1) no methionine (Control); (2) 2-hydroxy-4-methylthiobutanoic acid (HMB) (3) isopropyl HMB (HMBi); and (4) dl-methionine (dl-Met). The three supplemented diets were iso-Met. Dry matter intakes and milk yields were not different and averaged 20 kg/d and 37.7 kg/d, respectively. Milk protein concentration (2.91, 2.95, 3.02, 2.96%) and fat concentration (3.34, 3.12, 3.51, 3.69%) are reported here for control, HMB, HMBi, and dl-Met. Milk protein concentration was significantly increased with the HMBi treatment. Rumen VFA profile and NH₃ concentrations were similar. Addition of Met in all forms increased ruminal digestibility of OM and NDF over the control. Passage rates of small particles (0.071/h) and fluid (0.167/h) were not affected by treatment. Protozoa were increased numerically in the omasum by HMB and HMBi treatments. Proportion of omasal N from bacterial N was not different (0.64), and g of bacterial N flow were similar between treatments. The percentage of HMB that passed into the omasum was 5.3%. Only a small amount of HMBi was found as HMB in the omasum (2.3%).

Key Words: Dairy, Methionine, 2-hydroxy-4-methylthio Butanoic Acid

T222 Intravenous histidine infusion affects milk composition in lactating dairy cows. Y. H. Moon*², P. H. Luimes¹, L. E. Wright³, C. A. Toerien¹, and J. P. Cant¹, ¹*University of Guelph, Guelph, ON, Canada,* ²*RAIRC, Jinju National University, Jinju, Gyeong Nam, Korea,* ³*Elora Dairy Research Centre, Ariss, ON, Canada.*

Controlling milk composition nutritionally is a beneficial tool sought in many farming circumstances. The purpose of this study was to evaluate the potential of histidine to influence the production and composition

of milk in lactating dairy cows. Histidine was compared to methionine and lysine, and graded doses of histidine infusion were also evaluated. Forty-one multiparous (2.9 ± 0.5) Holstein cows (33 ± 1 DIM) were assigned by a randomized block design to one of six treatments. Cows were fed, ad libitum, a corn/alfalfa silage-based TMR containing 17.7% CP and 1.7 Mcal/kg NEL on a DM basis. Feed intake was recorded daily, and milk yield was recorded and sampled for analysis of composition twice per day. Treatments were saline (n = 7), 14.3 g/d methionine (n = 8), 45.4 g/d lysine (n = 8), 7.4 g/d histidine (n = 5), 14.7 g/d histidine (n = 8) and 29.4 g/d histidine (n = 5) and were infused into a jugular vein. Infusion rates for methionine, lysine and histidine (14.7 g/d) were designed to be equivalent to 500 g/d milk protein. Solutions were infused continuously for 4 d by peristaltic pump. The day before infusion served as a covariate period, and data from the last four days of infusion were analyzed with the Mixed procedure of SAS. Treatments were compared to control using the Dunnett-Hsu adjustment for differences between least squares means. Linear effects of histidine dose were analyzed by orthogonal contrast. Milk fat, protein and lactose contents were affected by treatment (P < 0.05). Histidine (7.4 g/d) resulted in lower lactose content compared to control (4.76 ± 0.02 vs. 4.83 ± 0.02%). Milk protein yield and the protein to fat ratio were affected by treatment (P < 0.05). Milk protein yield was 1,195 ± 38.1 g/d for the methionine treatment compared to 1,108 ± 39.5 g/d (P = 0.08) on the control. Increasing level of histidine infusion resulted in a linear increase in milk protein content, yield and ratio to milk fat (P < 0.05).

Key Words: Amino Acid, Jugular Infusion, Early Lactation

T223 Use of milk ammonia nitrogen as an indicator of rumen protein degradation in dairy cows. A. B. Peterson* and R. A. Kohn, *University of Maryland, College Park.*

The prediction of rumen protein degradation in lactating dairy cow rations is critical in diet formulation and to prevent overfeeding of nitrogen (N). Milk ammonia N (NH₄-N) may be a reliable indicator of rumen protein degradation. NRC 1989 and 2001 reported two different methods to predict RDP and RUP dietary content, intake and requirement. In 1989, NRC reported the RUP% in commonly used feedstuffs that can be used to predict the overall RDP and RUP content of the ration. In 2001, NRC used a systematic set of equations including digestion and passage rates as well as protein fractions (A, B, and C) to determine the same. The objective of this study was to compare different indicators of ruminal protein degradation: milk NH₄-N, soluble protein content of the diet and NRC 1989 and NRC 2001 predictions. Detailed herd and ration information as well as a TMR and bulk tank samples were collected from eight farms across Maryland repeatedly over two years (n=17; milk yield = 27.0 ± 5 kg). Milk NH₄-N averaged 17.8 ppm (± 0.8 ppm) and there was little variation across farms ranging from 16.5 to 19.1 ppm. Milk NH₄-N was correlated with the analyzed CP% of the diet (P < 0.05; R² = 0.35) which ranged from 14.9 to 25.3% (average = 18.1 ± 2.4%). Milk urea nitrogen (12.1 ± 2.1 mg/dl) was also correlated with analyzed CP% of the ration (P < 0.05), but milk NH₄-N and MUN were not correlated (P > 0.10). Predicted intakes of both RDP (2000 ± 320g) and RUP (1270 ± 230g) were not different using either the 1989 and 2001 NRC models (P > 0.10). Milk NH₄-N was not correlated with predicted dietary RDP and RUP content, intake, or balance as determined by either NRC 1989 or 2001 (P > 0.10). Additionally, milk NH₄-N was not correlated with measured dietary soluble protein (1170 ± 180g; P > 0.10). With the current data, milk NH₄-N was not correlated with predicted rumen protein degradation or level of excess RDP using 1989 or 2001 NRC models, but was correlated with dietary CP content.

Key Words: Milk Ammonia, Rumen Protein Degradation, Milk Urea Nitrogen

T224 Ruminal degradability and intestinal digestibility of treated soybean meal products. S. I. Borucki Castro*¹, H. Lapierre², L. E. Phillip¹, P. W. Jardon³, and R. Berthiaume², ¹*Animal Science - McGill University, Ste-Anne-de-Bellevue, QC, Canada,* ²*Dairy and Swine Research and Development Centre - Agriculture and Agri-Food Canada, Lennoxville, QC, Canada,* ³*West Central Soy, Ralston, IA.*

Four Holstein cows fitted with rumen and duodenal cannulae were used to determine rumen degradability and intestinal digestibility of physically and chemically treated soybean meal (SBM): solvent extracted

SBM (SE), expeller SBM (EP) -SoyPlus[®], lignosulfonate treated SBM (LS) -Surepro[™], heat treated SBM with soy hulls (HS) -Aminoplus[®] and chemically treated SBM (CT) -Top Soy[™]. Samples were milled through a 2 mm screen and 4 g (12.3 mg/cm²) placed in N-free polyester bags (pore size 50 μ m) according to a standardized procedure (NRC 2001). Duplicate bags of each feed were hooked to a stainless steel weight, soaked in 39 °C water for 20 min, and then inserted in the ventral sac of the rumen, for 48, 24, 16, 8, 4, 2 and 0 h. Four additional bags of each feed were incubated for 16 h to estimate intestinal digestibility *in situ*, using the mobile bag technique (Hvelplund and Weisbjerg 2000). Degradation kinetics were calculated with 6% of passage rate (NRC 2001). The presence of a lag phase was detected for ruminal DM degradability of LS, HS and CT and also for ruminal CP degradability of EP, LS, HS and CT. Effective degradability of DM was higher ($P \leq 0.001$) for SE (73.5%) compared to EP (61.0%), LS (62.9%), CT (63.1%) and HS (61.7%), while effective degradability of CP was higher ($P \leq 0.01$) for SE (67.8%) compared to EP (54.7%), LS (53.3%), CT (53.9%) and HS (52.6%). Intestinal disappearance of DM was higher ($P \leq 0.05$) for SE (91.4%) compared to EP (89.5%) but lower ($P \leq 0.05$) compared to LS (93.3%) and CT (96.3%) and not different compared to HS (91.8%). Intestinal disappearance of CP was lower ($P \leq 0.01$) for SE (96.6%) compared to LS (98.7%), CT (99.0%) and HS (98.2%) but not different compared to EP (97.5%). Physical or chemical treatment of SBM decreased rumen degradability but did not negatively affect intestinal digestibility of protein. Therefore these treatments would increase RUP from SBM with the potential to enhance the supply of bioavailable amino acids in the small intestine.

Key Words: Soybean Meal, Rumen Degradability, Intestinal Digestibility

T225 Effects of ruminally-protected L-carnitine intake on plasma L-carnitine, glucose, urea, and ammonia in sheep undergoing an ammonia challenge. D. K. Walker^{*1}, B. D. Lambert^{1,2}, H. B. Rathburn³, and J. C. Woodworth⁴, ¹Department of Animal Science, Tarleton State University, Stephenville, TX, ²Texas Agriculture Experiment Station, Stephenville, TX, ³Department of Biology, Tarleton State University, Stephenville, TX, ⁴Lonza Inc., Fairlawn, NJ.

Two experiments were conducted to evaluate the effect of dietary ruminally-protected L-carnitine (RPLC) on plasma L-carnitine (LC) concentrations and ammonia toxicity in sheep. In Exp. 1, wether lambs ($n=20$; 44.3 ± 0.98 kg) were randomly assigned to one of five treatments (0.25, 1.00, 2.50, 5.00, and 10.00 g/day) of dietary RPLC. Sheep were fed 2% of BW of a complete ration and allowed 20 d for adaptation. On d 20 of the experiment, plasma was obtained at 0, 120, and 240 min after RPLC feeding for LC analysis. Plasma LC concentrations increased ($P < 0.01$) from Day 0 (baseline) to Day 20 for all levels of RPLC treatment, however, no differences were observed due to level of RPLC or time. Plasma LC concentrations were 27.05 and 57.83 μ mol/L for baseline and pooled RPLC treated sheep, respectively. In Exp. 2, wether lambs ($n=20$; 36 ± 1.2 kg) were randomly assigned to one of four treatments (0, 0.125, 1.06, 2.0 g/day) of RPLC to evaluate the protective effects of dietary RPLC on sheep undergoing an ammonia challenge. Sheep were fed and adapted as in Exp. 1. On d 20 of the experiment, sheep received 300 mg/kg of BW of urea orally as an ammonia challenge. Plasma was collected at 0, 15, 30, 60, 90, 180, 240, and 360 min after feeding for metabolite analysis. Plasma LC concentrations increased with treatment relative to control ($P < 0.01$). Plasma LC concentrations were 35.7, 44.2, 60.5, and 65.7 μ mol/L for the 0, 0.125, 1.06, 2.0 g/day treatments, respectively. Levels of RPLC tended to have different effects on plasma ammonia across time (time treatment; $P=0.10$). Plasma glucose and urea were not affected by treatment. We conclude that feeding at least 1.0 g of RPLC once daily for 20 d increased circulating plasma LC concentrations in sheep. Additionally, this level of RPLC tended to reduce plasma ammonia concentrations at some time points during an ammonia challenge.

Key Words: Ruminant, Nitrogen, Toxicity

T226 Influence of slow-release urea on nitrogen flux in steers. C. C. Taylor^{*1}, S. E. Kitts¹, N. B. Kristensen¹, K. R. McLeod¹, D. E. Axe², and D. L. Harmon¹, ¹University of Kentucky, Lexington, ²IMC Feed Ingredients, Lake Forrest, IL.

Effects of urea or slow-release urea (SRU) on gut nutrient absorption and liver metabolism were investigated. Four steers (319 ± 5 kg body weight)

were surgically prepared with ruminal cannulas and hepatic portal, hepatic venous, mesenteric venous, and mesenteric arterial catheters. The basal diet was 90% corn silage and 10% ground corn-based supplement offered once daily at 1.5% of body weight (dry matter basis). Supplemental dietary nitrogen was provided by urea or SRU (mean 92 g/head) top-dressed daily onto the basal diet. Steers were fed dietary treatments for 3 weeks prior to sampling. On the day of sampling, p-aminohippuric acid (250 mM, pH 7.4) was infused continuously into the mesenteric vein catheter (approximately 1.3 mL/min) starting 1 h prior to feeding and continuing throughout the sampling period. After 1 h of infusion, blood was sampled to obtain a time zero sample. Each blood sampling consisted of simultaneously collecting arterial, portal and hepatic blood samples (10 mL each) into heparinized syringes. Immediately following the time zero sample, steers were offered the basal diet without the top-dressed urea treatments and their daily aliquot of urea or SRU was dosed into the rumen and mixed thoroughly. Blood samples were collected 0.5, 1, 2, 4, 6, 8, and 10 h post-dosing. SRU reduced mean ruminal ammonia concentration by 72% compared to urea (3.6 versus 12.9 mM; $P < 0.03$). SRU tended to decrease net portal flux of ammonia ($P < 0.08$) compared to urea. A treatment by time interaction was detected for hepatic ammonia uptake ($P < 0.02$); hepatic ammonia uptake increased rapidly (within 0.5 h) with intraruminal dosing of urea compared to SRU. These results demonstrate that SRU possesses the ability to release N slowly in the ruminant. Slow-release urea can reduce the rate of ruminal urea hydrolysis and may increase the synchrony of N release with carbohydrate digestion.

Key Words: Urea, Non-Protein Nitrogen, Ruminants

T227 Utilization of ammonia-N by ruminal epithelial and duodenal mucosal cells isolated from growing sheep. M. Oba^{*1}, R. L. Baldwin, VI², S. L. Owens¹, and B. J. Bequette¹, ¹Department of Animal and Avian Sciences, University of Maryland, College Park, ²Bovine Functional Genomics Laboratory, Animal and Natural Resources Institute, USDA-ARS, Beltsville, MD.

To determine the capability of ruminant gut tissues to detoxify ammonia-N, ruminal epithelial cells (REC) and duodenal mucosal cells (DMC) were isolated from growing Texel-Polypay ram lambs ($n=4$) fed a mixed forage-concentrate diet. Immediately after isolation, primary cells were incubated for 60 min with glucose (1mM), glutamate (1mM), [¹⁵N]ammonium chloride (0, 5, 10, 20, or 40 mM), and one of four combinations of substrate to support urea synthesis (1 mM each; control (no additional substrates), N-carbamoylglutamate (NCG), NCG + ornithine, NCG + ornithine + aspartate) in a 5 x 4 factorial arrangement of treatments. Incorporation of ammonia-¹⁵N into Ala, citrulline, Arg, and urea (nmol / 10⁶ cells / 60 min) was determined by gas chromatography-mass spectrometry. Utilization of ammonia-N for net Ala synthesis increased quadratically from 0.73 to 1.35 nmol for DMC ($P < 0.001$) and from 0.28 to 0.69 nmol for REC ($P < 0.001$) as the ammonia concentration increased from 5 to 40 mM, regardless of substrate treatments. For both cell types, ammonia-N incorporation into Ala was lower in the presence of NCG compared to control (1.18 vs. 1.39 nmol for DMC, $P < 0.001$; 0.52 vs. 0.59 nmol for REC, $P < 0.05$). For REC, ammonia-N was not incorporated into citrulline, Arg and urea, whereas for DMC ammonia-N was incorporated into citrulline but not Arg and urea. However, ammonia-N utilization for net citrulline synthesis by DMC decreased linearly from 0.68 to 0.27 nmol ($P < 0.001$) as ammonia concentrations increased from 5 to 40 mM. Thus, in ruminant gut tissues, Ala synthesis is probably a more significant disposal pathway to detoxify ammonia-N at high ammonia concentrations compared with disposal via the ornithine-urea cycle although DMC also possess a capability to incorporate ammonia-N into citrulline.

Key Words: Ruminal Epithelial Cells, Duodenal Mucosal Cells, Ammonia detoxification

T228 An improved analytical method for the determination of urea recycling parameters. J. C. Marini^{*}, University of Illinois, Urbana.

Urea metabolism has generated considerable interest in ruminant nutrition because of the ability of rumen microorganisms to produce amino acids from urea-N, which then can meet the needs of the host. More recently, interest has also been focused on reducing N excretion from which urea is the main component. Use of ¹⁵N¹⁵N-urea allows for the determination not only of urea production and recycling, but of the urea

recycled that returns to the ornithine cycle. Because of the large size of cattle and the cost of labeled urea, the targeted enrichments can only be determined by isotope ratio mass spectrometry (IRMS). Unfortunately, sample preparation for the original analytical method (Sarraseca et al., 1998, Br. J. Nutr. 79:79-88) was very laborious and time consuming. Furthermore, sample admission into the dual inlet IRMS was done manually. We have developed a fast and convenient method of sample preparation, with minimal supervision, with a fully automated sample admission into the IRMS. In brief, samples (6 mM urea, 2 mL) were placed into Exetainer tubes (Labco, UK) and helium was bubbled to displace dissolved air. Samples were then frozen and 0.4 mL of LiOBr was added (and frozen on top). The Exetainer screw cap was tightened and the headspace pumped out by a high vacuum system. Helium was then admitted into the Exetainers to achieve positive pressure. The samples were then incubated in a heat block at 65 °C for 20 min, where the $^{15}\text{N}^{15}\text{N}$ and $^{15}\text{N}^{14}\text{N}$ -urea reacted with LiOBR to yield ^{30}N and ^{29}N gas, respectively. The N gas generated was admitted into a PDZ Europa 20/20 continuous flow IRMS with a Gilson autosampler. The $^{15}\text{N}^{15}\text{N}$ -urea standard curve generated (range 0 to 0.32 atom % excess, ape) was $Y = 1.0009 (0.012) X + 0.0006 (0.002)$, $R^2 = 0.998$ (slope not different than 1, intercept no different than 0; $P < 0.05$), where Y was the measured and X the known enrichment in ape. The occurrence of the nonmonomolecular degradation of urea was $5.5 \pm 0.2\%$. This method of sample preparation for automated continuous flow IRMS is fast, convenient, and allows for a large sample throughput (16 samples/h).

Key Words: Urea Recycling, ^{15}N , N Metabolism

T229 Use of Synchrotron-based FTIR microspectroscopy to reveal chemical features of feather protein secondary structure and its relation to protein value. P. Yu*¹, J. J. McKinnon¹, C. R. Christensen^{2,3}, and D. A. Christensen¹, ¹College of Agriculture, University of Saskatchewan, Saskatoon, SK, Canada, ²Canadian Light Source, Saskatoon, SK, Canada, ³Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK, Canada.

Protein secondary structures include α -helix and β -sheet. The relative percentage of the two influences protein value. A high percentage of β -sheet may reduce the access of gastrointestinal digestive enzymes to the protein. Reduced accessibility results in poor digestibility and as a result, low protein value. Feather is widely available as a potential protein supplement. It is high in protein (84%), but the digestibility is very low (5%). The objective of this study was to use synchrotron-based Fourier transform infrared (S-FTIR) microspectroscopy to reveal chemical features of feather protein secondary structure within amide I at ultra-spatial resolution (pixel size: 1010 μm), in comparison with other commonly used sources of protein barley, oat and wheat. The experiment was performed at U2B station of the Albert Einstein Centre for Synchrotron Biosciences at the National Synchrotron Light Source in Brookhaven National Laboratory, US Dept of Energy (NSLS-BNL, New York). The results indicate that ultra-spatially resolved imaging of feather protein secondary structure by stepping in pixel sized increments (10 μm) was possible. Using synchrotron FTIR microspectroscopy one can distinguish between secondary structures of protein amide I among the different feed protein sources. The results show that the secondary structure of feather protein differed from other feed protein sources in terms of the line-shape and position of amide I. The feather protein amide I band showed a peak at ca. 1630 cm^{-1} , which is consistent with absorption peak of β -sheet protein amide I. However, the other feed protein sources showed a peak at ca. 1650 cm^{-1} , which is consistent with absorption peak of α -helix protein amide I. These results indicated that the secondary structure of feather protein contains a higher percentage of β -sheet. Such a difference in the protein secondary structure likely explains the poor biological value of feather protein.

Key Words: Synchrotron Infrared Microspectroscopy, Protein Secondary Structure, Amide I (α -helix, β -Sheet)

T230 Basolateral transport of neutral amino acids in enterocytes is mediated via Systems A, ASC, L, asc, and y^{+L} . J. Knapp*, University of Vermont, Burlington.

Enterocytes take up substantial quantities of amino acids (AA) from the systemic circulation via transporters located on the basolateral surface. Immortalized bovine intestinal cell lines VIE-1 and VIE-5 were used to determine the activities and kinetic properties of neutral

AA transport systems on the basolateral cell surface using the Transwell system. Differences in transport activity between cell lines were tested using Student's t test and kinetic parameter estimates were obtained from Eadie-Hofstee plots. Leucine (Leu) influx occurs through Na⁺-dependent (15-40%) and Na⁺-independent mechanisms (60-85%) in both cell lines. Na⁺-independent Leu influx was inhibited 20 and 35% by 10mM 2-aminobicyclo-heptane-2-carboxylic acid (BCH) in VIE-1 and VIE-5 cells, respectively, indicating that System L has a significant role in basolateral Leu transport. System y^{+L} that is not inhibited by BCH would also be expected to contribute significantly to Na⁺-independent Leu influx, while System asc would not because of substrate specificity. VIE-5 cells displayed more total Leu transport activity than VIE-1 cells. In contrast, VIE-1 cells exhibited more total alanine (Ala) influx activity than VIE-5 cells, and both lines were able to transport significantly more Ala than Leu at the same concentrations. Active Ala transport occurs through Na⁺-dependent (17-37%) and Na⁺-independent mechanisms (63-83%) in both cell lines. Na⁺-independent Ala transport would be a function of Systems L, asc, and y^{+L} . α -Methylaminoisobutyric acid was not able to inhibit all Na⁺-dependent Ala transport in either cell line, suggesting that there is another Na⁺-dependent transporter in addition to System A on the basolateral surface, most likely System ASC. While Systems A and L have been reported to be the major AA transporters on the basolateral surface of enterocytes, these results demonstrate the existence of other systems (ASC, asc, and y^{+L}) that are capable of transporting significant amounts of both small and large neutral AA.

Key Words: Amino Acid Transport, Intestine

T231 Investigation of the site of absorption and metabolism of HMBi and HMB in sheep. P. Nozière¹, C. Richard², B. Graulet², D. Durand¹, D. Remond¹, and J.C. Robert*², ¹INRA URH, Clermont-Ferrand Theix, Fance, ²ADISSEO France SAS, Briand, Antony, France.

The aim of this trial was to investigate the site of absorption of HMBi (2-hydroxy - 4 (methyl thio)-butanoic acid isopropyl ester) and HMB, and the site of hydrolysis of HMBi to HMB. Four sheep, adult castrated, Texel breed were assigned in a cross over design with 2 treatments (HMBi or HMB) and 2 periods. The animals were fitted with ruminal cannula, catheters on ruminal and portal veins, artery, and blood flow probes around the right ruminal artery and portal vein. Diet was hay and concentrate (70/30) given twice a day. Products were introduced intraruminally as a single dose (7.5 g methionine equivalent) just before the morning meal. Blood was collected at min. 0, 10, 20, 30, 50, 80, 120, 180 and 240 after introduction. Ruminal and portal net fluxes of HMBi, HMB, methionine, isopropanol and acetone were calculated from plasma concentrations and flows. For HMBi treatment, no HMBi was detected in the plasma at any site or time of blood collection but net appearance of both HMB and isopropanol were detected from the very start of blood collection and were maximum in the first hour after rumen introduction at both ruminal and portal drained viscera (PDV) levels. Net appearance of HMB across rumen and PDV wall were 5 times higher with HMBi vs. HMB. This indicates that HMBi is absorbed as HMBi and hydrolysed to HMB and isopropanol across the wall of the digestive tract and particularly across rumen wall. Arterial HMB and methionine peak values occurred at 20 and 180 min following introduction, respectively, and concentrations were 6 and 5 times higher with HMBi vs. HMB treatment. This was related to a higher entry rate of HMB with HMBi vs. HMB treatment Mean Area Under Curve of portal net flux (SD) = 2730 (864) vs. 588 (403) mg rather than methionine portal net flux which remained unchanged. This is coherent with higher methionine bioavailability of HMBi vs. HMB due to its higher absorption efficiency. This study contributes to better knowledge of the HMBi metabolism for methionine supply to the ruminant.

Key Words: Methionine, Ruminant, Bioavailability

T232 Relationship between body weight, loin Longissimus dorsi and backfat measurements, and body condition score in dry and lactating Holstein-Friesian dairy cows. G. Jaurena, J. M. Moorby*, W. J. Fisher, and D. W. R. Davies, Institute of Grassland and Environmental Research, Aberystwyth, UK.

Body condition score (BCS) is widely regarded as a measure of energy reserves, but it also relates to muscle mass. The lactation cycle of the dairy cow induces large changes in body fat and protein pools, which can be

monitored through loin backfat (BF) and Longissimus dorsi (LD) measurements. Data from two experiments (Exp) using Holstein-Friesian dairy cows ($n = 32$ and 40 respectively) were used to study the association of body weight (BW), BF and LD with BCS for the last 5 wk of the dry period (DP) and the first 8 wk of lactation. Loin and tail BCS were manually assessed (0-5 scale) and BF and LD were measured by ultrasound at the 5th lumbar process. The BCS data ranged from 1.2 to 3.0 units in the DP, and from about 1.1 to 3.1 units in lactation in both experiments. An autoregressive covariance structure to account for repeated measures within cows was used for data analysis by two models: BW, LD or BF = Exp + Per (DP or lactation) + BCS + Interactions + Cow + Measure within cow + Residuals (Model 1); and BCS = Exp + Per + LD + BF + Interactions + Cow + Measure within cow + Residuals (Model 2). Regressions of BW and LD on BCS (Model 1) found pre-to-post calving intercept differences ($P < 0.001$) of 43 kg BW and -3.3 mm LD, and slope coefficients of 35 (DP) and 21 (lactation) kg BW, and 5.8 mm LD per BCS unit. Regression of BF on BCS (Model 1) showed an Exp \times Per interaction ($P < 0.001$), with 0.4 mm BF (Exp 1; $P < 0.05$) and 2.0 mm BF (Exp 2; $P < 0.001$) per BCS unit. Regression of BCS on LD and BF (Model 2) showed intercepts $\neq 0$ ($P < 0.06$), and different ($P < 0.001$) between DP and lactation; BCS increased ($P < 0.001$) by 0.027 units/mm BF and 0.05 units/mm LD, but LD had a quadratic term -0.0004 ($P = 0.02$). It is concluded that at BCS lower than 3, LD contributes to BCS following a quadratic function, whereas BF increases BCS linearly. Each unit of BCS equated to about 35 and 20 kg BW for DP and lactation periods, 5.8 mm LD, and between 0.4 and 2.0 mm BF.

Key Words: Back Fat, Body Condition Score, *Longissimus dorsi*

T233 Predicting feed protein flow to the duodenum of lactating dairy cows. H. G. Bateman, II^{*1}, J. H. Clark², and M. R. Murphy², ¹LSU AgCenter, Baton Rouge, LA, ²University of Illinois, Urbana.

A data set constructed from research trials published between 1979 and 1998 was used to derive equations to adjust tabulated values for the rumen-undegradable protein (RUP) content of feeds and better predict flow of nonammonia-nonmicrobial N (NANMN) to the small intestine of lactating dairy cows. The data set contained 150 treatment means from 35 trials. Both linear and nonlinear forms of equations were considered for making adjustments. Iterative processes were used to estimate equation parameters. A logistic equation was developed and considered optimal for adjustment of tabulated RUP values. The equation is a function of the DMI and includes terms for tabulated RUP and NPN contents of the feeds. The equation eliminated both linear and mean bias from the prediction of NANMN flow to the duodenum and maintained the apparent RUP values of the feeds within the biologically valid range of zero to 100% of the CP. The equation had a standard error of prediction (SEY) of 82.6 g NANMN/d. An independent data set was constructed from trials published between 1998 and 2003 and used to evaluate the equation. The evaluation data set contained 51 treatment means from 12 research trials. The predicted flows of NANMN did not differ from measured flows ($P > 0.8$). The SEY for the evaluation data set was 99.1 g NANMN/d and the mean prediction error was 179 g/d. Analysis of the errors of prediction revealed that 94.9% of error was attributable to random variation with 5.1% correctable through a linear adjustment and only 0.02% was associated with errors in predicting the mean flow of NANMN to the duodenum. The equation developed was superior to tabulated values for RUP in predicting flow of NANMN to the duodenum of lactating dairy cows. As data become available that quantify the effects of factors other than DMI on the apparent RUP content of feeds, they should be incorporated into an adjustment equation to better predict flow of NANMN to the duodenum.

Key Words: Dairy, Rumen-Undegradable Protein, Prediction

T234 Prepro-ghrelin mRNA in the digestive tract of undernourished pregnant ewes. H.-C. Han^{*}, K. J. Austin, B. W. Hess, S. P. Ford, and T. R. Hansen, *Department of Animal Science, University of Wyoming, Laramie.*

Ghrelin, a peptide hormone purified from the gastric mucosa, activates growth hormone release, food intake and energy homeostasis. The greatest levels of ghrelin have been found in the gastric fundus of the rat. During fasting, the synthesis of ghrelin is stimulated in gastric endocrine cells. Ghrelin mRNA has been reported in bovine rumen and abomasum. We hypothesized that undernutrition would stimulate the expression of

ghrelin in the digestive tract of ewes during midgestation. Control ewes were fed pelleted beet pulp fortified with vitamins and minerals to meet requirements of early pregnancy, whereas the nutrient restricted group received 50% of the control diet from day 28-78 of gestation. On day 78 of gestation, ewes were slaughtered, and digestive tracts were removed, stripped of digesta, and trimmed of fat. Digestive tract tissues (rumen, abomasum, duodenum, jejunum) were harvested. A subsample was collected and snap frozen and the rest of the tissue was weighed. Total RNA was purified using TRI reagent. Ovine prepro-ghrelin cDNA was amplified, sequenced and random prime labeled for use on northern blots. Data (mean \pm SEM) were analyzed as a 2x2 factorial with diet ($n = 7$ control; $n = 6$ nutrient-restricted) and offspring number ($n = 6$ singles, $n = 7$ twins) as main effects using PROC GLM procedure. No interaction and no effect of offspring number was observed. Rumen weight was decreased significantly ($1022\text{g} \pm 51.4$ vs $765\text{g} \pm 61.4$; $P = 0.03$) in nutrient restricted when compared to control fed ewes while there was no change in abomasal weight ($215\text{g} \pm 20.1$ vs $211\text{g} \pm 21.4$; $P > 0.05$). Northern blot analysis showed that prepro-ghrelin mRNA was abundantly expressed in the abomasum, while rumen, duodenum, and jejunum expressed little or no prepro-ghrelin mRNA. However, prepro-ghrelin mRNA did not differ in the abomasum of nutrient restricted ewes when compared to control fed ewes ($P > 0.05$). These results are interpreted to mean that prolonged undernutrition during pregnancy in the ewe does not alter the expression of prepro-ghrelin in the maternal abomasum. NIH P20RR16474.

Key Words: Ruminant, Nutrition, Ghrelin

T235 Effects of forage proportion in the diet on digestibility and portal nutrient flux in sheep fed to maintenance level. G. F. Mouro, A. F. Branco^{*}, S. M. Coneglian, T. F. Minella, L. P. Rigolon, L. M. Zeoula, and F. J. Maia, *Universidade Estadual de Maringa, Parana, Brasil.*

Three Suffolk wethers, weighting 50 kg, fitted with mesenteric vein, portal vein and mesenteric artery catheters were used to evaluate the effects of forage proportion in the diet on digestibility and portal nutrient flux. The design was a 3 x 3 Latin square. Treatments were as following: 30, 40 and 50% of corn silage in the diet (as dry matter basis). Digestibility was determined using total collection of feces. Portal plasma flow was determined by continuous infusion of *P*-aminohippurate, and net nutrient flux was calculated as the difference between venous and arterial concentration times blood flow. Intake, digestion and digestibility of dry matter, organic matter and crude protein were not influenced by forage level. Neutral detergent fiber intake increased linearly ($P < .05$) as result of corn silage ($y = 399.36 + 1.42(x - x)$, g/d) increase in the diet. Intake ($y = 280.21 - 4.09(x - x)$, g/d) and digestion ($y = 253.71 - 4.19(x - x)$, g/d) of non fiber carbohydrates decreased linearly ($P < .05$) as result of corn silage increase in the diets. Intake of total digestible nutrients was not affected by forage level. Forage level in the diet did not influence portal plasma flow. Portal and arterial concentrations of glucose and alpha-amino-nitrogen were not affected by forage level in the diet, and averages were 3.715 and 3.725 mM for glucose and 3.302 and 3.045 mM for alpha-amino-nitrogen. Portal flux of glucose and alpha-amino-nitrogen were not affected by forage level and were -940 and 43.208 mM/h, respectively. Portal concentration ($y = .522 - .00101(x - x) + .00074(x - x)^2$, mM) and portal flux ($y = 40.927 - .05068(x - x) + .14165(x - x)^2$, mM/h) of ammonia showed a quadratic response ($P < .05$) to forage level. Corn silage increase in the diet produced a quadratic response ($P < .05$) in portal ($y = 2.577 + .00263(x - x) + .00170(x - x)^2$, mM) and arterial ($y = 2.622 + .00122(x - x) + .002(x - x)^2$, mM) urea concentration. There was no effect of forage level on portal urea flux.

Key Words: Metabolism, Portal Drained Viscera, Forage

T236 Effects of carbohydrate source and monensin in high oil diets on nitrogen balance, digestibility and portal nutrient flux in sheep. G. F. Mouro, A. F. Branco^{*}, F. J. Maia, T. F. Minella, L. M. Zeoula, and S. M. Coneglian, *Universidade Estadual de Maringa, Parana, Brasil.*

The objectives of this research were to evaluate utilization of two carbohydrate sources (soybean hulls and corn) with and without monensin in sheep diets with high vegetable oil inclusion, and effects on nitrogen balance, digestibility and portal nutrient flux. Were used four Corriedale wethers, weighting 54 kg on average, and fitted with

catheters in mesenteric and portal vein and mesenteric artery. Digestibility and nitrogen balance were determined using total collection feces method. Portal plasma flow was determined by continuous infusion of *P*-aminohippurate, and net nutrient flux was calculated as the difference between venous and arterial concentration times blood flow. Intake, fecal excretion, digestion and digestibility of dry matter (DM), organic matter (OM) and ether extract (EE) were not affected by treatments. Intake (g/d), digestion (g/d) and digestibility (%) of neutral detergent fiber were higher ($P < .01$) for soybean hulls diets (SBHD) (757, 531.1 and 70.2, respectively) than for corn diets (CD) (392.3, 199.9 and 60, respectively). CD had higher ($P < .01$) non fiber carbohydrates intake (g/d), digestion (g/d) and digestibility (%) than SBHD (474.6 vs 148, 416.8 vs 97.8 and 87.8 vs 66.1, respectively). CD (80.2%) had higher ($P < .05$) total digestible nutrients than SBHD (76.8%). Fecal protein excretion (g/d) was lower ($P < .04$) and protein digestibility (%) was higher ($P < .02$) for CD (49.3 and 77.1, respectively) than for SBHD (61.9 and 72.6, respectively). There was no effect of monensin on nutrients digestibility and nitrogen balance. Treatments did not affect glucose concentration in arterial and portal plasma, and portal glucose flux. Alpha-amino-nitrogen concentration (mM) in arterial and portal plasma were lower ($P < .04$) for diets with monensin (3.268 and 2.992, respectively) than for diets without monensin (3.423 and 3.147, respectively). Portal concentration (mM) and portal flux of ammonia (mM/h) were lower ($P < .03$) for CD (.419 and 26.119, respectively) than for SBHD (.516 and 37.041, respectively). Treatments did not affect urea concentration in arterial and portal plasma, and portal urea flux.

Key Words: Metabolism, Portal Drained Viscera, Monensin

T237 Two techniques to determine the ruminal clearance rate of volatile fatty acids. J. C. Resende Júnior¹, M. N. Pereira^{*1}, H. Boer², and S. Tamminga², ¹Universidade Federal de Lavras, Lavras, Brazil, ²Wageningen Universiteit, Wageningen, The Netherlands.

Removal (clearance) of VFA from the rumen occurs by absorption through the rumen wall and by passage to the omasum with rumen liquid. The objective of this experiment was to compare measurements of fractional clearance rates obtained with the HVal-Co technique with measurements obtained with ¹³C labeled VFA. The exponential decay rate of the ¹³C/¹²C ratio after pulse dosing ¹³C-Acetate, ¹³C-Propionate or ¹³C-Butyrate into the rumen was compared to the decay rate of rumen valerate concentration following a pulse dose of 300 grams of valerate. Each labeled VFA, the unlabeled valerate and Co-EDTA were concurrently mixed to the evacuated ruminal content of six lactating cows in two 3x3 Latin Squares. The fractional clearance of VFA by passage to the omasum was assumed to be equal to the decay in ruminal Co concentration and was around 50% of the total clearance. The fractional clearance rates of all VFA were similar, showing that chain length was not a factor in the irreversible loss of ¹³C introduced into the rumen as each acid. Absorption rates varied from 14 to 19 %h⁻¹ and was higher for propionate than for butyrate. Linear regression determination coefficients using valerate clearance rate as estimator of the clearance rates of acetate, propionate and butyrate were 0.51, 0.56, and 0.99, respectively. In a second experiment, the decay rate of ¹³C-Valerate was similar to that obtained with unlabeled valerate by the HVal-Co technique. There was no increase in ¹³C enrichment of rumen microbes four hours after intraruminal infusion of ¹³C-Valerate. The fractional VFA absorption rates obtained with the stable isotopes technique gave results similar to that obtained with the HVal-Co technique.

Key Words: Acetate, Propionate, Butyrate

T238 Prediction of milking cows performance and use of the equations for estimating nutritional requirements in Brazil. R. P. Lana^{*1,2}, J. A. Freitas¹, and A. C. Queiroz^{1,2}, ¹Universidade Federal de Viçosa-DZO, Viçosa, MG, Brazil, ²CNPq, Brasília, DF, Brazil.

The objectives of this research were to develop prediction equations of dry matter intake, energy and protein requirements, and to validate the NRC (1989, 2001) for predict milking cows performance under typical Brazilian production conditions. Data from 33 pure Holstein to Holstein/Zebu cows were used in this study. The average body weight (BW), daily milk production (Milk), milk fat (Fat), milk protein (Ptn), daily dry matter intake (DMI) and their respective standard deviations

were 499±37 kg; 21±3 kg; 3.9±0.4%; 3.2±0.3%; and 17±2 kg, respectively. The composition (%) of dietary crude protein (CP), total digestible nutrients (TDN), ethereal extract (EE) and neutral detergent fiber (NDF) of the diet was 16.4±1.5; 69.4±5.5; 4.2±2.7; and 42.6±9.4, respectively. Prediction equations of DMI, milk production and nutritional requirements are presented below.

DMI = -100 + (0.116*BW) + (2.91*Milk) + (22.8%*Fat) - (2.6%*%Fat²) - (0.00483*BW*Milk); R² = 0.91; Eq.1

Milk = -24.4 + (0.0227*BW) + (0.891*DMI) - (0.232%*NDF) + (0.412%*TDN); R² = 0.95; Eq.2

Milk = 36.1 - (0.364%*NDF); R² = 0.59; Eq.3

%CP = -49.9 + (0.429*BW) - (35.4%*Fat) + (20.9%*Ptn) + (4.4%*Fat²) - (3.18%*Ptn²) - (0.000445*BW²); R² = 0.75; Eq.4

%TDN = [Milk + 24.4 - (0.0227*BW) - (0.891*DMI) + (0.232%*NDF)]/0.412; Eq.5

%NDF = (36.1 - Milk)/0.364 = 99.1 - (2.75*Milk); Eq.6

%TDN = (47.4 + Milk - (0.0227*BW) - (0.891*DMI) - (0.64*Milk))/0.412; Eq.7

Equations 5, 6 and 7 were derived from equations 2 and 3. Equations 1, 4, 6 and 7 allow us to estimate the nutritional requirements of DM, CP, NDF and TDN, respectively, as a function of BW, Milk, fat, and protein. These equations can be used in computer programs for ration formulation and to generate tables of nutritional requirements for milking cows under typical Brazilian production conditions. These equations are more efficient in predicting the cow's performance than NRC (1989, 2001), in which the NRC (2001) was inadequate by over-predicting milk production by 92%.

Key Words: Dry Matter Intake, Milk, Nutritional Requirements

T239 Efficiency of use of concentrate ration on weight gain and milk production by cattle under tropical pasture and intensive conditions in Brazil. R. P. Lana^{*1,2}, ¹Universidade Federal de Viçosa-DZO, Viçosa, MG, Brazil, ²CNPq, Brasília, DF, Brazil.

The feed efficiency (FE; kg of weight gain; or milk production/kg of supplement) of using concentrate rations was evaluated in cattle in pasture and intensive production conditions. The efficiency of weight gain was obtained from 25 published studies examining growing cattle receiving supplementation during the dry season, and seven studies examining growing cattle being fed different forage to concentrate ratios in feedlot conditions. FE were calculated by the coefficient of the linear regression equation of the weight gain as a function of the concentrate intake, in addition to the calculation of the gain accretion as a function of concentrate intake. The efficiency of milk production was calculated by dividing the increase in milk production as a function of the concentrate intakes from nine published pasture and one free-stall research studies. Pasture reared cattle had FE from 7 to 10:1, while feedlot cattle had FE of 10:1. When pasture-reared cattle consumed a mineral salt treatment, FE was improved by 0.1 to 0.14 kg of weight gain/kg of consumed concentrate; and in feedlot studies FE increased by 0.1 kg/kg of consumed concentrate. When dairy cows were reared on pasture FE ranged between 0.04 and 0.1 kg of weight gain/kg of concentrate consumed; milk production efficiency (MPE) was 0.65 ± 0.41 kg of milk/kg of concentrate consumed, and MPE was improved to 1.8 kg of milk/kg of concentrate consumed by feeding whole cottonseed. For dairy cows raised in free stall conditions, MPE ranged between 0.29 and 0.48 kg of milk/kg of concentrate consumed, due in part to high levels of concentrate in the control diets. The high cost of concentrate feeds compared to the pasture and the low efficiency of the concentrate conversion in weight gain and milk under tropical pastures, as verified above, can explain the low use of concentrate by Brazilian farmers, which can have greater profitability in spite of low cattle performance.

Key Words: Cattle, Concentrate Conversion, Supplement

T240 Ruminal parameters and plasma metabolites of Holstein dairy cows fed processed cottonseed. A. R. Foroughi^{*}, A. A. Naserian, R. Valizadeh, and M. Danesh mesgaran, Ferdowsi University of Mashhad, Iran.

Whole cottonseed (WCS) is of significant feeding value for average and high-yielding dairy cows. Multiparous cows (n=8) averaging 84.50±10.34 days in milk and 36.10±4.46 milk yield were used in a 4x4 Latin square design. Cows were divided into four groups, receiving one of the following treatments: 1) WCS; 2) Ground cottonseed (GCS);

3) GCS heated in 140°C and steeped for 2.5 minute (GHCS1); or 4) GCS heated in 140°C and steeped for 20 minute (GHCS2). The percentage of whole or processed cottonseed was fixed at 14%. Total mixed diets had the following composition, dry matter 79.5%, NDF 35.2%, CP 18.5% and NEL 1.58 (Mcal/KgDM). Each period consisted of 21 days and the last 7 days were used for dry matter intake (DMI). Ruminal samples were taken via stomach tube and ruminocentesis on 21d of each period at approximately 2h postfeeding. Ruminal pH was measured in fresh samples immediately, and samples were analyzed for N-NH₃. Blood samples were taken from coccygeal blood vessels at the time of ruminal sampling. The mean DMI was significantly ($P < 0.01$) affected by diets and in treatments of 1,2,3 and 4 were 25.97, 27.24, 27.63, and 27.63 (kg/d), respectively. Supplementation with HGCS2 resulted in decreased ($p < 0.01$) in ruminal N-NH₃ concentrations and in treatments of 1,2,3 and 4 were 14.63, 16.31, 12.48, and 10.52 respectively. This represented a 28% decrease between WCS and HGCS2. Blood urea showed the same pattern observed for ruminal N-NH₃. Physical processing of WCS did not affect ruminal pH and mean for stomach tube and ruminocentesis method was 6.6 and 6.1, respectively. Significant differences ($p < 0.05$) were observed in glucose and cholesterol concentrations, but processing of WCS did not affect ruminal triglycerides, albumin and low density lipoproteins.

Key Words: Processed Cottonseed, Ruminal Parameters and Plasma Metabolites

T241 NutriDense® corn grain and corn silage for dairy cows. B. C. Benefield*, I. R. Ipharraguerre, M. o Liñero, and J. H. Clark, *University of Illinois, Urbana.*

Sixteen intact multiparous Holstein cows and four multiparous Holstein cows surgically fitted with ruminal cannulas, averaging 71 days in milk, were used in a replicated 4 x 4 Latin square to compare the effects on digestibility and animal performance of feeding either NutriDense®, stacked with the “leafy” trait (NDL), or yellow dent corn control (YDC) whole plant silage; and either grain from NutriDense® corn (ND) or YDC hybrid. Diets contained 30.56% corn silage and 27.65% corn grain (DM basis) produced from one of the NDL, ND, and the YDC hybrids. Data from this experiment show that the CP, NDF, ADF, and EE content of NDL and ND were higher and NFC and starch were lower than that of the YDC hybrid. Dry matter intakes (mean = 27 kg/d) were similar ($P < .7$) for the four diets (YDC silage + YDC grain, NDL silage + YDC grain, YDC silage + ND grain, and NDL silage + ND grain). NutriDense grain and NDL silage decreased ($P < .01$) NFC and starch intake but increased ($P < .01$) EE and N intake. Feeding NDL silage increased ($P < .01$) NDF and ADF intake but did not affect DMI. These differences in nutrient intake arose from variations in the composition of the corn grains and silages. Starch digestibility was higher ($P < .05$) for the NDL silage + YDC grain diet but digestibility of other nutrients were not different among treatments. Ruminal pH and concentrations of VFA and NH₃N in rumen fluid were not different among treatments ($P > .05$). Production of milk, 3.5% FCM, fat, CP, true protein, and total solids (mean = 36.5, 37.6, 1.34, 1.21, 1.14, 4.57 kg/d, respectively), and the percentages of milk fat, CP, true protein, and total solids (mean = 3.71, 3.32, 3.13, 12.58, respectively), were not affected by treatments. Milk urea N (mean = 11.6 mg/dl) was higher ($P < .001$) for cows fed diets containing ND grain; this may be because of higher N intakes for those diets. Results indicate that NDL silage and ND corn were similar to the control hybrid for the feeding of lactating dairy cows.

Key Words: NutriDense, Corn Silage, Dairy Cows

T242 Effect of level of dietary crude protein on ruminal digestion and bacterial NAN flow in lactating dairy cows. J. J. Olmos Colmenero*¹ and G. A. Broderick², ¹University of Wisconsin, Madison, ²U.S. Dairy Forage Research Center, Madison, WI.

Ten ruminally fistulated Holstein cows were used in an incomplete 5 x 5 Latin square design with 4, 4-wk periods to assess the effects of different dietary CP levels on ruminal digestion and bacterial NAN flow. Diets contained (DM basis) 25% alfalfa silage, 25% corn silage, and 50% concentrate. High moisture corn was replaced with solvent soybean meal to increase CP from 13.7%, to 15.1%, 16.6%, 18.1%, and 19.6%. Samples of digesta were taken from the reticulo-omasal orifice and the true digesta flow was calculated using a triple marker approach (indigestible NDF, Co-EDTA and Yb-acetate). The marker used to quantify bacterial NAN

was ¹⁵N. DM and OM intakes were not different among treatments. As expected, N intake increased linearly with CP content in the diet. DM and OM flow, apparent rumen OM digestibility (AROMD), OM truly digested in the rumen (OMTDR), and liquid associated bacteria (LAB) flow did not differ. The flows of particle associated bacteria (PAB) and total bacterial NAN, and bacterial efficiency were not different but significant linear effects of CP level were detected. Under the conditions of this study, total bacterial NAN was not increased by feeding more than 16.6 % CP.

Item	CP, % DM							
	13.7	15.1	16.6	18.1	19.6	SE	P>F	Linear
DM intake, kg/d	21.9	22.9	23.8	23.5	22.5	1.2	0.50	0.37
OM intake, kg/d	20.7	21.6	22.4	22.1	21.0	1.1	0.53	0.48
Nitrogen intake, g/d	476 ^d	556 ^c	632 ^b	679 ^{ab}	708 ^a	32	<0.01	<0.01
OM flow, kg/d	11.3	11.5	12.4	12.3	11.7	0.7	0.50	0.23
OMTDR, kg/d	14.0	14.6	15.0	14.8	14.2	0.8	0.77	0.66
LAB NAN flow, g/d	243	237	274	254	246	20	0.61	0.56
PAB NAN flow, g/d	183	177	207	226	229	22	0.15	0.01
Total bacterial NAN flow, g/d	425	415	479	480	475	35	0.28	0.04
Bacterial efficiency, g/kg OMTDR	30.6	28.4	31.8	32.7	32.9	1.5	0.07	0.02

a,b,c,d Means in rows without common superscripts differ ($P < 0.05$).

Key Words: Dietary Crude Protein, Microbial Nitrogen Flow

T243 Effect of species and breed within species on forage intake and growth in hair sheep lambs and meat goat kids offered alfalfa and grass hay diets with a corn-based supplement. S. Wildeus¹, K. E. Turner*², and J. R. Collins¹, ¹Virginia State University, Petersburg, ²USDA, ARS, AFSRC, Beaver, WV.

Feed intake, growth, live grade, and blood metabolites were measured in 36 intact male hair sheep lambs, equally representing Barbados Blackbelly (BB), Katahdin (KA), and St. Croix (SC) breeds, and 36 intact male goat kids, equally representing F₂ Boer cross (BX), Myotonic (MY) and Spanish (SP) breed types in a 98-d pen feeding study. Animals were allocated to 8 pens at 3.5 mo of age stratified by species and breed type, and offered either tall fescue (*Festuca arundinacea* Shreb.; FES; 13.5% CP, 56.1% NDF, 37.9% ADF, 45.2% IVOMD) grass or alfalfa (*Medicago sativa* L.; ALF; 16.3% CP, 51% NDF, 36.1% ADF, 55.2% IVOMD) hay (4 pens/forage type) plus a corn (*Zea mays* L.)-based concentrate (16% CP) at 2% BW. Forage DMI decreased ($P < 0.01$) during the trial, and ALF DMI was higher ($P < 0.01$) initially, but similar to FES as the trial progressed. The ADG was greater ($P < 0.001$) for hair sheep (165 g/d) than goats (106 g/d), and was greater when offered ALF (153 g/d) than FES (118 g/d) diets. When offered ALF diets, blood urea nitrogen (BUN; 21 vs. 19.9 mg/dl) and glucose (71 vs. 66.9 mg/dl) were higher ($P < 0.01$) compared to FES diets. Live grade was higher ($P < 0.01$) in hair sheep than goats, and when offered ALF than FES. Within hair sheep, there were no differences in ADG and live grade between breeds, although KA had higher ($P < 0.01$) starting and final BW (42.7 vs. 36.2 and 38.2 kg, respectively) than BB and SC. In goats, BX had higher ($P < 0.001$) starting and final BW, and greater ($P < 0.01$) ADG than MY and SP (133 vs. 84 and 99 g/d). Live grade in goats was higher ($P < 0.05$) on ALF than FES, but not affected by breed. Goats had lower ($P < 0.01$) blood concentrations (mg/dl) of BUN (18.9 vs. 22.1), creatinine (0.55 vs. 0.58), and glucose (65.6 vs. 72.2) than hair sheep. Results suggest that an improved forage base in the diet uniformly increased performance independent of small ruminant species and/or breed.

Key Words: Small Ruminants, Forage Feeding, Growth

T244 Productive performance of Holstein cows in early and very early lactations when injected with bovine somatotropin. M. A Tarazon*¹, J. T. Huber², A. C. Calderon³, and H. G. Garcia³, ¹Universidad de Sonora, México, ²University of Arizona, Tucson, ³Universidad Autónoma de Baja California, Mexicali, Mexico.

The objective of the current study was to evaluate the effect of bovine somatotropin (bST) on milk yield and composition of Holstein cows in early and very early lactations. Twenty-two lactating Holstein cows averaging 62 days in milk (DIM:25-115), 28.5 kg/d milk, a body condition score (BCS) of 2.87, and 648.2 kg of body weight (BW), were assigned to one of the four treatments in a completely randomized design with a treatment arrangement of factorial 2x2. Cows were fed with the regular diet during the fourteen days of pretreatment and the 56 days of treatment periods. The treatments were: 1). VE, cows in very early lactation (25-56 DIM) without bST; 2). VES, cows in very early lactation with bST; 3). E, cows in early lactation (67-115 DIM) without bST; and 4). ES, cows in early lactation with bST. Variables were adjusted for covariance effects using the data from the 28-day pretreatment period and analyzed by the General Linear model Procedure (GLM) of SAS (1990). Results showed that bST tended (P<0.09) to increase milk yield (34.8 vs. 36.4 kg/d) in cows between 25 to 115 DIM, however the increase was significant when bST was injected to cows in early lactation (67-115 DIM). Neither the stage of lactation nor the injection of bST altered milk composition nor the rest of variables measured in the experiment.

Key Words: bST, Holstein, DIM

T245 Effect of type of concentrate on milk production and composition of dairy cows. R.G. Pulido*¹, P. Aguilera¹, R. Daetz¹, F. Wittwer¹, and P. Orellana², ¹Fac. Cs. Veterinarias, Universidad Austral de Chile, Valdivia, Chile, ²Depto. Nutrición, F. Med. Veterinaria, Universidad de Concepción.

Two experiments were carried out to evaluate the effect of two sources of carbohydrate (fibrous and starchy) and two levels of crude protein in

concentrate supplements (17.0% in exp 1 and 11.9% in exp 2) on milk production and composition of spring calving dairy cows. In exp 1, 12 multiparous Friesian dairy cows (BW 529 kg), yielding 33.0 l/d and at 53 days of lactation, were assigned to a 3x3 Latin square design with periods of 21 days. In exp 2, 30 multiparous Friesian dairy cows (BW 512 kg), yielding 29.3 l/d and at 65 days of lactation, were assigned to a continuous randomized design for 45 days. For both experiments the treatments included: grazing alone (TGO), grazing plus 6 kg/d of sugar beet pulp-based concentrate (TFC) and grazing plus 6 kg/d of cereal-based concentrate (TSC). The concentrates were balanced by CP and ME. The cows were supplemented twice a day and managed under a strip grazing system on pasture consisting mainly of perennial rye grass. During the last week of each period in exp 1 and during all period, in exp 2, milk production (MY) was recorded on a daily basis and milk composition on 4 occasions during each week. Throughout the trial BW was recorded weekly. The results for (MY) during exp 1 were 24.2, 28.5 and 29.8 l/d for treatments TGO, TCF and TCS, respectively (TGO vs. TCF or TCS, P<0.05; TCF vs. TCS P>0.05). Milk fat (MF) was 3.65, 3.44 and 3.40 %, respectively (P=0.06), milk protein (MP) was 2.88, 2.99 and 3.01 %, respectively (TGO vs. TCF or TCS, P<0.05; TCF vs. TCS P>0.05) and milk urea was 43.35, 41.01 and 43.89 mg/dl, respectively (P>0.05). The results for (MY) during exp 2 were 27.0, 28.9 and 31.0 l/d for treatments TGO, TCF and TCS, respectively (TGO vs. TCF or TCS, P<0.05; TCF vs. TCS P>0.05). (MF) was 3.59, 3.58 and 3.73 %, respectively (P>0.05), (MP) was 3.07, 3.30 and 3.14 %, respectively (TGO vs. TCF or TCS, P<0.05; TCF vs. TCS P>0.05) and milk urea was 48.59, 42.72 and 44.65 mg/dl, respectively (P<0.05). The results suggest that carbohydrate source did not affect the milk production and composition of dairy cows on this experiment.

Key Words: Grazing Cows, Milk Yield, Carbohydrates

Sheep Species

T246 Effect of substitution of alfalfa hay with sun dried pig excreta on performance of sheep feed growing diets. A. Estrada-Angulo*, C. H. Ramos, R. Barajas, and J. F. Obregon, FMVZ-Universidad Autonoma de Sinaloa, Culiacán-Mazatlan, Mexico.

With the objective of determining the effect of substitution of alfalfa hay with sun dried pig excreta on performance of sheep fed growing diets, a 56 days growing feeding experiment was conducted. Forty hair sheep (Males; BW=15±2 kg) were used in a complete randomized block experiment design. The animals were weighed and blocked by weight in groups of four. Groups were placed in eight pens (2 x 3 m) with a bare ground floor and designed to consume one of two diets that constituted the treatments: 1) Diet with 18% CP and 3.1 Mcal of DE/kg, containing 30% of alfalfa hay, sudan grass hay 10%, cracked corn 29.5%, soybean meal 13%, sugar cane molasses 14%, mineral premix 2.5% (Control); and 2) Diet similar to control, but containing 30% of sun dried pig excreta, that substituting entirely for the alfalfa hay. Diets were offered twice a day under free access condition. There was not effect (P=0.48) of treatments on end weight (23.60 vs. 23.28 kg for diet 1 and diet 2, respectively). The inclusion of pig excreta did not affect (P=0.73) the dry matter intake (0.773 vs. 0.775 kg/day for diet 1 and diet 2, respectively). The average daily gain was similar (P=0.62) for both treatments (152.25 vs. 148.75 g/day for diet 1 and diet 2, respectively). The feed intake/gain ratio was not altered (P=0.72) by treatment (5.16 vs. 5.13 for diet 1 and diet 2, respectively). It is concluded, that sun dried pig excreta can be used as partial substitute of roughage in diets for growing sheep.

Key Words: Pig Excreta, Growth Performance, Sheep

T247 Effect of substitution of sorghum grain for escobero sorghum grain (sorghum bicolor, var. Technicum, Jav.) on apparent digestibility of diets for sheep. A. Estrada-Angulo*, R. Barajas, J. F. Obregon, R. E. Lopez, and J. C. Robles, FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico.

With the objective of determining the effect of substitution of sorghum grain for escobero sorghum grain (sorghum bicolor, var. Technicum, Jav.) on apparent digestibility of diets for sheep, a digestibility experiment by total fecal collection was conducted. Four pelibuey sheep, males (BW=22.75±0.32 kg) were used in a crossover design experiment. The animals were placed in individual metabolic crates (0.6 x 1.2 m), and randomly were assigned to consume one of two diets that constituted the treatments: 1) Diet with 15% CP and 3.4 Mcal of DE/kg, containing 45% of whole sorghum grain, sudan grass hay 22.5%, sesame meal 15%, sugar cane molasses 12%, poultry fat 3%, and 2.5% of mineral premix (Control); and 2) Diet similar to control but containing 45% of whole escobero sorghum grain (Sorghum bicolor var. technicum, Jav.), that substituted for sorghum grain of the diet (ES treatment). Diets were offered twice a day (800 and 1600 h), after a six days adaptation period, samples of diet (1 kg) and the total of feces produced were collected for four days. Samples were dried, weighed, and ground. The inclusion of escobero sorghum increased (P=0.01) the amount of DM excreted in feces (151 vs. 215 g/day for control and ES, respectively) and fecal excretion of crude protein (25 vs. 32 g/day for control and ES, respectively). ES decreased (P<0.01) by 15.5% dry matter digestibility of the diet (74.45 vs. 62.94% for control and ES, respectively). The crude protein apparent digestibility was 9.5% lower (P=0.02) in ES treatment (70.8 vs. 64.06% for control and ES, respectively). Digestible energy of the diet was diminished (P<0.01) 16% by ES (3.18 vs. 2.67 Mcal/kg for control and ES, respectively). Digestible energy content of sorghum bicolor, var. Technicum, Jav. was calculated to be 2.75 Mcal/kg and the true digestibility of its protein was calculated to be near 72%. It is concluded, that inclusion of sorghum bicolor, var. Technicum, Jav. decreased digestibility and DE content of the diet for sheep.

Key Words: Sorghum Grain, Digestibility, Sheep

T248 Effect of substitution of sorghum grain with escobero sorghum grain (*Sorghum bicolor*, var. *Technicum*, Jav.) on growth performance of finishing sheep. A. Estrada-Angulo*, R. Barajas, J. F. Obregon, and F. J. Gallardo, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico*.

With the objective of determining the effect of substitution of sorghum grain with escobero sorghum grain (*Sorghum bicolor*, var. *Technicum*, Jav.) on growth performance of finishing sheep, thirty two hair sheep (males, BW=27.85 kg) were used in a complete randomized block experiment design. The animals were weighed and blocked by weight in groups of four. Groups were placed in eight pens (2 x 3 m) with a bare ground floor, and assigned to consume one of two diets that constituted the treatments: 1) Diet with 15% CP and 3.4 Mcal of DE/kg, containing 60% of Whole sorghum grain, corn straw 10%, SBM 10%, sugar cane molasses 14.5%, and 2.5% of mineral premix (Control); and 2) Diet similar to control, but containing 60% of whole escobero sorghum grain (*Sorghum bicolor*, var. *Technicum*, Jav.), substituting for sorghum grain (ES treatment). Diets were offered twice a day under free access condition. Average daily gain was not affected ($P=0.26$) by treatments (219 vs. 202 g/day for control and ES respectively). Feed intake was increased ($P<0.01$) in 21% for escobero sorghum (1.07 vs. 1.298 kg/day for control and ES respectively). Feed/gain ratio was negatively affected ($P=0.02$) by the inclusion escobero sorghum in the diet (5.11 vs. 6.43 for control and ES respectively). It is concluded, that the inclusion of sorghum bicolor, Var. *Technicum*, Jav, substituting to sorghum grain, decreased growth performance response of finishing sheep.

Key Words: Sorghum Grain, Varieties, Sheep

T249 Effect of substitution of alfalfa hay with Clitoria hay (*Clitoria ternatea* L.) on performance of sheep feed finishing diets. A. Estrada-Angulo*, A. B. Perez-Fernandez, J. F. Obregon, R. Barajas, and E. A. Velazquez, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico*.

To determine the effect of substitution of alfalfa hay with Clitoria hay (*Clitoria ternatea* L.) on performance of sheep fed finishing diets, a 28 day growth performance experiment was conducted. Twenty four Pelibuey sheep (males, initial BW=20.7 kg) were used in a complete randomized Block design experiment. The animals were weighed and grouped by weight. Groups of three were allocated in one of eight pens (2 x 3 m) with a bare ground floor fitted with metal feed bunks (1 x 0.33 m) and waters. The pens were randomly assigned one of two diets that constituted the treatments: 1) Diet with 18.3% of CP and 3.015 Mcal of DE/kg, containing (DM basis), alfalfa hay 50%, (18.01% CP), ground corn 27.8%, soybean meal 9.75%, sugar cane molasses 9.58%, urea 0.57%, limestone 1.15%, and mineral premix 1.15% (control); and 2) Diet same as control, but containing 50% of clitoria hay (19.09% CP), that substituted for all alfalfa hay of the control diet. The animals were weighed at day 1 and 28 of the trial. DM intake was recorded daily. The mean final weight of experiment was 26.9 kg and was not altered ($P=0.48$) by roughage source in diets. Dry matter intake was not affected ($P=0.74$) by treatment with values of 1.009 and 1.014 kg/day for alfalfa and clitoria diets, respectively. Average daily gain was similar ($P=0.20$) for both treatments with means of 0.208 and 0.190 kg/day for alfalfa and clitoria diets, respectively. There were no differences ($P=0.32$) in the dry matter intake/ADG ratio, with values of 4.92 and 5.34 kg/kg for alfalfa hay and clitoria hay diets respectively. It is concluded that clitoria hay can be included up to 50% in the diets of finishing sheep substituting for alfalfa hay without detrimental effect on performance.

Key Words: Clitoria ternatea, Alfalfa Hay, Sheep

T250 Effect of supplementation of meat meals from different non ruminant species on growth performance response in finishing sheep. A. B. Perez-Fernandez, A. Estrada-Angulo*, R. Barajas, and J. F. Obregon, *FMVZ-Universidad Autónoma de Sinaloa, Culiacan-Mazatlan, México*.

To determine the effect of supplementation of meat meals from different non ruminant species on growth performance response in finishing sheep, a 56 days feeding experiment was performed. Eighty Pelibuey sheep (males; BW=23.16 kg) were used in a complete randomized experiment design. Animals were weighed and divided in groups of five.

Groups were placed 16 pens (2x3 m) with a bare ground floor, and randomly assigned to consume one of four diets containing different kind of meat meal that constituted the treatments; protein sources were: 1) Diet with 15% CP and 3.5 Mcal of DE/kg containing Sesame meal as protein supplement (control); 2) Diet containing 6% of fish meal as protein supplement (FM); 3) Diet containing 6% of Pork meat meal (PMM); and 4) Diet with 6% of poultry meal (POM). Diets were offered twice a day (0800 and 1600 h) under free access condition. Pork meat meal reduced ($P<0.01$) feed intake (1.207 vs. 1.100 kg/day for control and PMM respectively), and tended to decreased ($P=0.07$) average daily gain (209 vs. 185 g/day for control and PMM respectively). The treatments did not affected ($P>0.20$) the feed/gain ratio. It is concluded that growth performance of finishing sheep can be altered by the source of meat meal from different nonruminant species.

Key Words: Fish Meal, Pork Meat Meal, Poultry Meal

T251 Comparative effect of tallow and dark poultry fat on apparent digestibility of diets for sheep. A. Estrada-Angulo*, J. C. Robles, J. F. Obregon, and R. Barajas, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico*.

With the objective of comparing the effect of tallow and dark poultry fat on apparent digestibility of diets for sheep, four Pelibuey sheep (males, BW=17.62±0.27 kg) were used in a CrossOver design experiment. The animals were placed in individual metabolic crates (0.6 x 1.2 m), and randomly were assigned to consume one of two diets that constituted the treatments: 1) Diet 15% CP and 3.4 Mcal DE/kg, containing sudan-grass hay, tallow 3%, sorghum grain 45%, sesame meal 15%, sugar cane molasses 12%, and mineral premix 2.5% (Control); and 2) Diet similar to control, but containing 3% of dark poultry fat substituting for the tallow (DPF). Diets were offered twice a day (800 and 1600 h), after a six days of adaptation period, samples of diet (1 kg) and the total of feces produced were collected for four days. Samples were dried, weighed and ground. Treatments did not affected ($P=0.20$) the amount of dry matter (118 vs. 110 g/day for control and DPF respectively) and crude protein (20 vs. 18 g/day for control and DPF respectively) excreted in feces. Apparent digestibility of the diet was similar ($P=0.32$) for both treatments (73.66 vs. 75.28% for control and DPF respectively). Apparent digestibility of crude protein was equal ($P=0.14$) for both treatments (68.43 vs. 72.68% for control and DPF respectively). Digestible Energy content of the diets was not altered ($P=0.30$) by the fat sources. It is concluded, that the dark poultry fat can substituting for tallow in diet for sheep without alter its digestibility.

Key Words: Tallow, Poultry Fat, Sheep

T252 Digestibility of fermented bagasse fed to Suffolk ewes. R. Pradhan*¹, E. Shirakabe¹, T. Nishioka¹, and K. Batajoo², ¹*School of Agriculture, Kyushu Tokai University, Kumamoto, Japan*, ²*Chubu Feed Co. Ltd., Nagoya, Japan*.

Bagasse is a fibrous byproduct remaining after the production of cane sugar. Raw bagasse as such has low feed value and is typically burned at the sugar mill for fuel. Fermented bagasse is produced by fermenting raw bagasse with molasses and special microbial culture mix. In Japan, bagasse is imported from Thailand and is fed as a fiber source to beef cattle, dairy and beef heifers. Field trials indicate that fermented bagasse increases feed intake in beef cattle. Nutrient digestibility and animal performance data of fermented bagasse are limited. Nine mature Suffolk ewes (average age 4.3±0.9 years and body weight 69.4±9.7 kg) were divided into three groups (three animals per group) and fed experimental diet for 8 weeks. Experimental diets (DM basis) were: FB (fermented bagasse 70% + tofu cake mix 30%), FB+TH (35% fermented bagasse + 35% timothy hay + 30% tofu cake mix), TH (70% timothy hay + 30% tofu cake mix). Tofu cake mix consisted of wheat bran 40%, rice bran 5%, tofu cake 10%, barley 10%, corn 15% and beet pulp 20%. Tofu cake mix contained 17% CP, 37% NDF and 36.43% nonfiber carbohydrate (NFC). Total tract digestibility, rumination time, rumen fluid pH, ammonia and VFA were measured during the last week of 8 week period. Fecal and urine sample were collected for 5 days. Rumen DM disappearance at 48 hour (conducted in fistulated dry Holstein cows) were: FB 31.5%, TH 69.1%, and tofu cake mix 87.4%. FB had lower intake, digestibility and N retention compared to TH. FB+TH showed higher intake, nutrient digestibility and similar rumination time relative

to FB. Based on this study fermented bagasse is palatable but not recommended to be fed as a sole forage source. Its inclusion in sheep diet should be less than 35% when fed along with other forages.

		FB	FB + TH	TH
Intake, g/d	DM	1356	1693	1402
Digestibility, %	DM	49 ^a	58 ^b	68 ^c
	CP	66	68	65
	NDF	46 ^a	57 ^{ab}	66 ^b
	ADF	38 ^a	45 ^{ab}	57 ^b
N retention *	Intake	1.14	1.52	1.30
	Fecal	0.39	0.49	0.45
	Urinary	0.54	0.83	0.57
	Retained	0.21	0.20	0.28
Rumen	pH	7.45	7.28	7.21
	Ammonia, mg/dl	12.54	11.39	14.19
Rumination:intake ratio		0.983	1.139	1.444

*gN per kg metabolic body weight;

a,b,c within the same row differ ($P < 0.05$).

Key Words: Fermented Bagasse, Digestibility, Sheep

T253 Chemical diet composition and metabolizable protein intake by grazing sheep. A. S. Juarez-Reyes*, J. Arzola-Nevarez, G. Nevarez-Carrasco, R. Montoya-Escalante, and M. A. Cerrillo-Soto, *Universidad Juarez del Estado de Durango, Mexico*.

The aim of this study was to determine the chemical composition of the diet and the metabolizable protein (MP) intake by sheep grazing a scrubland in North Mexico. Three sheep (52.0 ± 7.2 kg BW) belonging to a herd of 100 animals and fitted with esophageal cannulae were used to collect monthly extrusa samples from August 2002 to May 2003. Animals were sampled two days each month at 1100 and 1530 for 45 minutes. Extrusa samples were analyzed for CP, NDF, ADF, lignin, hemicellulose, cellulose and *in vitro* digestibility with pepsine cellulase. Metabolizable Protein content was performed by the PDI (Intestinal Digestible Protein) model. Dry matter intake was estimated by: total fecal production/1-digestibility. To determine the effective degradability (ED) of CP, 5 g DM samples were incubated in nylon bags for 0, 3, 7, 12, 24, 48, 72 and 96 h, in 3 rams fed alfalfa and concentrate (70:30). The CP degradation was established by: $p = a + b(1 - e^{-ct})$, where p is CP disappearance from the bags, a the soluble fraction, b the insoluble but potentially degradable fraction, c the base of natural logarithm, t the rate of degradation of b and t the period of incubation. The data were analyzed using a completely randomized design. Mean DM intake was 1 kg/d. Chemical composition was different ($P < 0.05$) between months. Mean values of CP, NDF, ADF, lignin, hemicellulose, cellulose and *in vitro* digestibility contents were 176, 542, 369, 141, 190, 228 and 556 g/kg DM, respectively. The mean ED value was 70.8% with a range from 60.4 to 93.7% ($P < 0.05$). Microbial protein (Mp) derived from dietary nitrogen (MpN: 77 g/kg organic matter fermented in the rumen (OMFR)) was higher ($P < 0.05$) than that derived from dietary energy (MpE: 36 g/kg OMFR). Thus, the energy consumption was the limiting factor to microbial growth. The mean value of MP intake for pregnancy was 69 g/d (MpE: 36 g/kg + bypass protein: 33 g/d). Metabolizable protein requirements for maintenance (50 g/d) and late pregnancy (67 g/d) were satisfied but not the lactation requirements (115 g/d). Under the conditions of this study, to increase the utilization of degradable protein and thus, the MP consumption, an energy degradable supplement may be necessary.

Key Words: Sheep, Grazing, Metabolizable Protein

T254 Effect of chromium methionine supplementation on growth performance and carcass traits of hair sheep. F. Juarez*, R. Barajas, M. A. Espino, J. F. Obregon, and F. G. Rios, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico*.

With the objective of determining the effect of inclusion of 0.0, 0.4 and 0.8 ppm of chromium (from chromium methionine) in the diet on growth performance of hair sheep, sixty hair sheep (Males; BW= 17.3 kg) were used in a complete randomized block experiment design. The animals were weighed and blocked by weight in group of five. Groups were placed in twelve pens with earth floor (2 x 3m), and assigned to consume one

of three diets that constituted the treatments: 1) Diet with 14.1% CP and 3.0 Mcal of DE/kg, containing corn straw 15%, corn grain 55.0%, soybean meal 15.5%, sugar cane molasses 12% and mineral premix 2.5% (Control); 2) Diet similar to control but containing 0.4 ppm of Cr; and 3) Diet similar to control but containing 0.8 ppm of Cr. Animals were weighed on days 1, 28, and 56. Feed was offered twice a day under free access condition. Treatments did not affect ($P > 0.30$) end weight (29.16, 30.57, and 30.10 kg for 0, 0.4, and 0.8 ppm Cr respectively), feed intake (0.898, 0.910, and 0.902 kg of DM/day for 0, 0.4, and 0.8 ppm Cr respectively), average daily gain (0.211, 0.236 and 0.229 kg/day for 0, 0.4, and 0.8 ppm Cr respectively) or feed/gain (4.302, 3.891 and 3.962 for 0.0, 0.4 and 0.8 ppm Cr respectively). Hot carcass weight, carcass yield, rib eye area, and back fat were not affected ($P > 0.10$) by treatments. It is concluded, that the inclusion of 0.4, and 0.8 ppm of chromium methionine in the diet, does not affect growth performance and carcass traits of hair sheep.

Key Words: Chromium Methionine, Growth-Performance, Sheep

T255 Effect of chromium methionine supplementation on serum concentration of triglycerides and cholesterol of fattening sheep. F. Juarez*, M. A. Espino, and R. Barajas, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico*.

With the objective of determining the effect of chromium methionine supplementation on serum concentration of triglycerides and cholesterol of fattening sheep, twelve Pelibuey Tabasco sheep (Males 15.46 ± 0.45 kg) were used in a complete randomized experiment design. Animals were placed in individual metabolic crates, and were randomly assigned to consume one of three diets that constituted the treatments: 1) Diet with 14.1% CP and 3.0 Mcal of DE/kg, containing corn straw 15%, corn grain 55.0%, soybeans meal 15.5%, sugarcane molasses 12%, and mineral premix 2.5% (Control); 2) Diet similar to control but containing 0.4 ppm of Cr; and 3) Diet similar to control but containing 0.8 ppm of Cr. Blood samples were collected from the jugular vein on days 1, 14, 28, 42, and 56, serum was obtained by centrifugation, and triglycerides and cholesterol analyses were performed by spectrophotometric methods. On day 14, 0.4 ppm Cr increased ($P < 0.01$) serum triglycerides level (20.5 vs. 20.7 mg/dL for control and 0.4 ppm Cr respectively), Cr 0.8 ppm had not effect ($P > 0.20$) relative to control, a quadratic effect of Cr ($P < 0.01$) was observed. On day 28, 0.4 ppm Cr decreased ($P = 0.04$) serum triglycerides (32.0 vs. 24.5 mg/dL for control and 0.4 ppm Cr respectively). Across all timepoints 0.8 ppm Cr decreased ($P = 0.07$) triglycerides serum levels (28.9 vs. 23.9 mg/dL for control and 0.8 ppm Cr respectively). Cr supplementation linearly decreased ($P = 0.09$) cholesterol on day 14 (47.5, 42.5, and 38.0 mg/dL for control, 0.4 ppm Cr, and 0.8 ppm Cr respectively). It is concluded that, chromium methionine supplementation reduced serum triglycerides concentration, and its impact on serum cholesterol level is only observed during the start of the feeding period in sheep.

Key Words: Triglycerides, Serum Cholesterol, Sheep

T256 Effect of substitution of canola meal with overcooked sesame meal on growth performance of hair sheep. J. F. Obregon*, A. Estrada-Angulo, and R. Barajas, *FMVZ-Universidad Autónoma de Sinaloa, Culiacan-Mazatlan, Mexico*.

With the objective of determining the effect of substitution of canola meal with overcooked sesame meal on growth performance in hair sheep during the finishing phase, thirty two hair sheep (males; BW=26.23 kg) were used in a complete randomized block experiment design. The animals were weighed and blocked by weight in groups of four. Groups were placed in eight pens (2 x 3 m) with a bare ground floor and assigned to consume one of two diets which constituted the treatments: 1) Diet with 15.97% CP and 3.31 Mcal of DE/kg, containing (DM) Sudan grass hay 20%, corn grain 49%, canola meal 20%, sugarcane molasses 8.4%, and mineral premix 2.6% (control); and 2) Diet similar to control, but containing 20% of sesame meal substituting for the canola meal. Animals were weighed on day 1 and day 28 at which time the trial was completed; feed was offered twice a day under free access condition. Treatments did not affect ($P > 0.2$) end weight (32.75 vs. 32.54 kg), feed intake (1.115 vs. 1.288 kg of dry matter/day), average daily gain (0.234 vs. 0.225 kg/day) or feed/gain (4.76 vs. 5.72) for canola meal and sesame meal

respectively. It is concluded, that overcooked sesame meal can be included in diets for finishing sheep, substituting for canola meal without altering performance in hair sheep in the finishing phase.

Key Words: Sesame Meal, Canola Meal, Hair Sheep

T257 Ruminal degradation of dry matter of raw cull chop suey beans (*Vigna radiata* L., Wilzeck) in sheep. J.F. Obregon*, J.C. Robles, R. Barajas, A. Estrada-Angulo, and M. Valdez, *FMVZ-Universidad Autonoma de Sinaloa (Mexico)*.

This study was designed to determine the ruminal degradation of dry matter (DM) of raw cull chop suey beans (*Vigna radiata* L., Wilzeck) in sheep. Two Pelibuey sheep (31.5 kg) fitted with ruminal cannulas were used. The animals were fed with a diet 25:75 roughage:concentrate, containing 20% of raw cull chopsuey beans. Nylon bags (10 x 18 cm) containing 5 g of raw cull chop suey beans (CCB) or soybean meal (SBM) were randomly designated to be incubated in rumen of sheep for 3, 6, 9, 12, 18, 24, and 36 hours. After the incubation was completed, the bags were washed with tap water and DM was determined. DM degradability at 3 hours was similar ($P=0.19$) for SBM and CCB (39% vs. 42.82%, respectively), the ruminal degradation of CCB-DM was greater than SBM-DM ($P<0.02$) at 18 hours incubation time (92.87 vs. 83.02%, respectively). After 36 hours of rumen incubation, there were no differences ($P>0.63$) between CCB-DM and SBM-DM degradation (95.32 vs. 93.75%, respectively). Soluble fraction (a), degradable fraction (b) and rate of degradation (c) of CCB-DM were 25.58%, 70.95%, and 0.134%/hour, respectively. While values of 27.68%, 77.09%, and 0.076%/hour for fraction a, b, and c, respectively, were obtained for SB-DM. The effective dry matter of CCB degraded in rumen was calculated in 87.03%. It is concluded that dry matter of raw cull chopsuey beans is highly degradable and rapid degraded in rumen of sheep.

Key Words: Chop Suey Beans, Rumen Degradability, Sheep

T258 Ruminant degradation of dry matter of overcooked sesame meal using nylon bag technique in sheep. J. F. Obregon*, H. Castro, R. Barajas, A. Estrada-Angulo, G. Telles, and Y. Peraza, *FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico*.

The nylon bag technique was used to determine the ruminal degradation of sesame meal dry matter in sheep. Three sheep (Pelibuey males, BW=32 kg) were fitted with rumen cannula. The animals were fed a diet containing corn straw 13%, corn grain 55.5%, soybean meal 20%, sugar cane molasses 9%, and mineral premix 2.5% (16.5% CP and 3.55 Mcal DE/kg). Nylon bags (10x18 cm) containing 5 g of sesame meal (SM) or soybean meal (SBM) were randomly designated to be incubated in rumen of sheep for 3, 6, 9, 12, 18, 24, 36, or 48 hours. After removal from the rumen the bags were washed with tap water and DM was determined. The DM disappearance from nylon bags was higher ($P<0.01$) for soybean meal than sesame meal for all times of incubation, DM degradability was 35.05% vs. 30% at 3 hours, 67.8% vs. 46.05% at 12 hours, 87.36% vs. 53.05% at 24 hours and 97.4% vs. 63.9% at 48 hours for soybean meal and sesame meal respectively. Soluble fraction (a), degradable fraction (b) and rate of degradation (c) were 25.46%, 40.70% and 0.054%/h for SM, respectively. While values of 19.37%, 82.47%, and 0.067%/h for fraction a, b, and c, respectively, were obtained for SBM. The effective dry matter of SM degraded in rumen was calculated in 55.7%. It is concluded that dry matter of sesame meal is less degradable by and more slowly degraded in the rumen of sheep.

Key Words: Sesame Meal, Rumen Degradability, Sheep

T259 Genetic resistance to *Eimeria* infections in Merinoland sheep and relationships among oocyst count, *E. ovinoidalis* antibody level and live weight. M. Gauly*¹, J. Reeg², C. Bauer³, H. Brandt², C. Mertens⁴, H. Zahner³, and G. Erhardt², ¹*Institute of Animal Breeding and Genetics, University of Göttingen, Göttingen, Germany*, ²*Department of Animal Breeding and Genetics, University of Giessen, Giessen, Germany*, ³*Institute of Parasitology, University of Giessen, Giessen, Germany*, ⁴*Intervet Innovation GmbH Zur Propstei, Schwabenheim, Germany*.

Genetic parameters in resistance to *Eimeria* infections were studied in Merinoland sheep lambs (n = 222) descending from 179 ewes and sired by 10 rams, using *Eimeria* oocyst counts (oocysts per gram of faeces,

OpG) and *E. ovinoidalis* antibody level index (Ab) as marker traits. Faecal samples were taken individually in all lambs beginning at an age of 17 until an age of 40 days every third and afterwards every sixth day, respectively. The presence and number of oocysts were determined (OpG) using the modified McMaster method with saturated NaCl as the flotation fluid, which allowed the detection of a minimum of 100 OpG (MAFF, 1986). Blood samples were taken from all lambs at an age of 7, 40 and 80 days to measure antibody level using a Sandwich-ELISA (Nolan et al., 1986). Based on that Ab was calculated (Zahner et al., 1981). All lambs were individually weighed at birth and at 21, 40, 80, 120 and 150 days of age. Male lambs were slaughtered with a weight of 42 kg and females with 39 kg. OpG and Ab were transformed as the decimal logarithm or logarithm to correct for heterogeneity of variance and to produce approximately normally distributed data. 1714 samples (33.6 %) were oocyst negative while 3392 samples (66.4 %) were positive. Every lamb shed at least once oocysts. Even animals with high oocyst counts did not show any visible signs of sickness. Heritabilities of decimal log OpG were between 0.00 and 0.79 (s.e. 0.27). Mean log Ab was decreasing from a level of 0.33 (s.d. 0.13) at day 7 to a level of 0.13 (s.d. 0.07) at day 40 before the value increased again to 0.25 (s.d. 0.13) at day 80, respectively. The estimated heritabilities for log Ab measured at days 7, 40 and 80 were between 0.00 and 0.02 (s.e. 0.06), respectively. Phenotypic correlations among log OpG and body weight ranged between $r = -0.07$ ($p > 0.05$) and $r = -0.25$ ($p < 0.01$), respectively. The corresponding correlations between log Ab at various ages and body weight averaged between $r = -0.09$ ($p > 0.05$) and $r = 0.27$ ($p < 0.05$), respectively

Key Words: *Eimeria* Resistance, Antibody Level, Oocyst

T260 Phenotypic correlations between body measurements and production performance of six sheep breeds at north-central México: exploratory trial. M. A. Gallegos-Acevedo, N. Nieves-Herrera, C. F. Arechiga, J. I. Aguilera, M. A. Castillo-Pecina, and M. A. Lopez-Carlos*, *Universidad Autonoma de Zacatecas, Zacatecas, Mexico*.

Body measurements of 72 young rams (4 to 6 months of age) of different breeds (Rambouillet n=17, Suffolk n=5, Blackbelly n=8, Dorper n=8, Kathadin n=21 and Pelibuey n=14) were correlated with their production performance. Seventeen parameters, scrotal circumference (SC), body weight (BW), body length (BL), shoulder height (SH), shoulder width (SW), hindquarter height (HH), hindquarter width (HW), heart girth (HG), abdominal girth (AG), metacarpus circumference (MCC), metatarsus circumference (MTC), knee circumference (KC), neck circumference (NC), shoulder width (SW), wide of the back (WB), average daily gain (ADG) and feed conversion (FC) were measured 90 days apart (two times during the trial), as an exploratory test to develop a simple "on farm" ram selection method, and selection indexes for these breeds on local production conditions. Highest phenotypic correlations of 0.90 - 0.91 were found between BW and HG, for all breeds except for Dorper where a correlation of 0.34 was found. Some authors have found high relations between BW and BL, but in this trial medium values were obtained (0.45 - 0.62). Correlations between BW, HH, NC, KC and WB obtained high values (0.72 - 0.85). The measurements of the bone mass, MCC and the MTC, obtained high values of correlation (0.75 - 0.82) with BW, HG and AG. SC had low (0.20) to medium (0.40 - 0.50) correlations with other parameters measured. ADG obtain intermediate correlations with bone measurements MCC and MTC (0.45 - 0.53) and FC a low relationship (-0.02-0.015) with all parameters measured except with BW (0.73). Different correlation values were found for different breeds included in this trial, demonstrating that these measurements are related to the breed body shape and size. This exploratory trial could help us to develop a simple "on farm" method for selection of rams.

Key Words: Sheep, Phenotype, Genetic Traits

T261 Effect of breed type, finishing treatment, and dietary supplements on carcass characteristics and tenderness in hair sheep. M. Fisher¹, S. Duckett*¹, and S. Wildeus², ¹*The University of Georgia, Athens*, ²*Virginia State University, Petersburg*.

Thirty-six lambs were used to determine the effects of breed, finishing diet, and CP level of supplement on carcass quality and tenderness. Lambs from three hair sheep breeds (Barbados Blackbelly [BB];

Katahdin [K]; and St. Croix [STX]) were assigned to two finishing diets (pen [PEN] vs. pasture [PAST]) and supplemented with 12% (LOW) or 18% (HIGH) CP. Lambs finished in PEN received chopped, moderate quality grass hay; whereas lambs finished on PAST were allowed to graze native, predominantly fescue pasture. Lambs were harvested, and carcass data and loin samples collected at 24 h postmortem. Loin were aged at 4°C for 14 d and frozen for subsequent Warner-Bratzler shear force (WBS) measurement. Data were analyzed as a 3 x 2 x 2 factorial design to evaluate the effects of breed, finishing diet, supplemental CP level, and all possible interactions. Hot carcass weight (HCW) and ribeye area (REA) were greater ($P < 0.05$) for K than BB or STX. Carcasses from STX had heavier ($P < 0.05$) HCW but smaller ($P < 0.05$) REA than BB. Flank streaking was greater ($P < 0.05$) for K and STX than BB. Leg scores and quality grades were greater ($P < 0.05$) for K than BB or STX, which were similar. Body wall thickness was greater ($P < 0.05$) for K and STX than BB. The three-way interaction between breed, finishing diet and CP supplementation was significant ($P < 0.05$) for fat thickness. Fat thickness was higher ($P < 0.05$) for K fed HIGH on PAST than K-PAST-LOW, K-PEN, or STX and BB regardless of finishing diet and CP level. Fat thickness was lower ($P < 0.05$) for BB fed HIGH on PAST than K-PAST regardless of CP level or K-PEN-LOW. For WBS, HIGH increased ($P < 0.10$) WBS in BB but CP supplementation level did not alter WBS for STX or K. Hair sheep breed influenced carcass quality with K having heavier HCW and greater quality grades. Finishing diet and CP supplementation only influenced fat thickness levels but did not alter other carcass variables.

Key Words: Lamb, Hair sheep, Tenderness

T262 Characterizing exfoliative vaginal cytology (ECV) in ewes from 60 d of age through parturition. G. Solis, J. I. Aguilera, R. M. Rincon, R. Bañuelos, and C. F. Arechiga*, *Universidad Autonoma de Zacatecas, Zacatecas, Mexico.*

Present work try to characterize exfoliative vaginal cytology (EVC) from 60 d of age through parturition of Border-Leicester X Rambouillet lamb ewes from Mexican highlands of Zacatecas (22° 58' of north latitude and 102° 31' of west latitude above 2,153 m above the sea level). Vaginal smears (n=967), were obtained from ewes (n=8), from d 60 of age until parturition through different developmental stages: Pre-puberty, Puberty, Estrous Cyclicity, Pregnancy, Parturition. Papanicolau staining was performed to identify cellular types on vaginal smears. During the Pre-pubertal stage of ewe lambs (n=541 smears), basal (B) cells were mainly predominant followed by intermediate (I) and superficial (S) cells (B=84.62%; I=14.52%; S=0.41%). At the beginning of Puberty (n=8 smears), superficial cells were mainly predominant (B=1%; I=4%; S=84%), however, during the Estrous Cyclicity stage, (n=263), intermediate cells predominate with considerable populations of basal and superficial cells (B=23.1%; I=49.9%; S=26.62%). During Pregnancy (n=148 smears), there was an increase of intermediate cells (B=8.77%;

I=77.57%; S=11.95%). At Parturition (n=7), there was tendency to decrease intermediate cells and increase superficial cells (B=19%; I=38%; S=38.86%). Thus, we can conclude that in the Pre-pubertal stage there is a high population of basal cells. At the beginning of Puberty, there is high proportion of superficial cells (estrogen influence). During Estrous cyclicity there is a double amount of intermediate cells in comparison with basal and superficial cells (progesterone dominance). During Pregnancy, there is a high dominance of intermediate cells (high progesterone influence) and finally, at Parturition, there is a tendency to decrease intermediate cells (decreased progesterone) and to increase superficial cells (increased estrogens), until both cell types reach similar ratios.

Key Words: Ewe, Cytology, Vaginal Smears

T263 Sexual behavior and interaction of hair rams as an auxiliary aid for estrus detection in bovine females. C. F. Arechiga*, M. G. Magallanes¹, N. Nazarala¹, R. M. Rincon¹, J. A. Piña¹, M. A. Lopez¹, and J. Valencia², ¹*Universidad Autonoma de Zacatecas, Zacatecas, Mexico,* ²*Universidad Nacional Autonoma de Mexico, Mexico.*

Sexual behavior of hair rams (Black-belly, n=2) expressed by interaction with bovine females was evaluated as a possible auxiliary for visual estrus detection of cows included in artificial insemination programs. Bovine females (n=8), were dairy cows (n=3) and beef heifers (n=5). Sexual behavior of hair rams was evaluated on response to bovine-ovine interaction, to be used as ovine-teasers on estrus detection of bovine females, based on a previous adaptation period of 120 d. Then, bovine females were induced in estrus by a prostaglandin injection. 56 h post-administration of prostaglandins, hair rams were introduced into a pen with bovine females. Sexual behavior and interactions were recorded among both species by video-camera films. 100% of bovine females (8/8) were induced in estrus by 72.84 ± 5.12 h after prostaglandin injection. Estrus duration was 11.91 ± 5.64, bovine females performed 77 mounts, received 74 mounts, showed 12 anxiety signs and 6 cases of presence of vaginal mucus. In contrast, 42.9% of females (3 of 7), showed natural estrus 20.6 d after induced estrus. Performing 45 mounts, receiving 30 mounts, and 2 cases of presence of mucus without showing anxiety signs. Sexual behavior of hair rams in both types of estrus was: 20 courtships, 13 followings, 9 sniffings, 5 Flehmen reflexes, 3 territory markings, 2 masturbations and 2 homosexual mounts within male rams (adult and young rams). In conclusion, a hair ram is capable of showing sexual interest to bovine females in estrus. Such type of behavior, could help to visually detect bovine females in early estrus, independently of age (cows and heifers) or type (dairy and beef). Sexual behavior of rams seems to be acquired by a previous adaptation period of 120 d of interaction with bovine females.

Key Words: Estrus Detection, Sexual Behavior, Hair Sheep

Extension Education

T264 Financial performance of dairies in Florida and Georgia in 2002. A. deVries¹, R. Giesy¹, L. O. Ely*², A. deAraujo¹, A. Andreasen¹, B. Broadus¹, S. Eubanks¹, D. Mayo¹, P. Miller¹, T. Seawright¹, and C. Vann¹, ¹*University of Florida, Gainesville,* ²*University of Georgia, Athens.*

The Dairy Business Analysis Project (DBAP) includes an annual survey of the financial performance of dairies primarily located in Florida and Georgia. Its objective is to document the dairies financial success using standardized, accrual accounting methods in order to calculate benchmarks and provide feedback on the dairies financial strengths and weaknesses. Twenty-nine dairies submitted financial data in 2002. Twenty-seven dairies were included in the summary results. Of these, 18 were located in Florida, 8 in Georgia and one in Alabama. The average herd size was 1,168 cows and 583 heifers with 16,810 lbs. milk sold per cow. The average culling rate was 34%. There was an average of 20 FTE workers per farm and 1,010,000 lbs milk sold per FTE worker. Total revenue per cwt. was \$17.67 / cwt with \$16.05 / cwt milk income. The average total expense was \$17.88 / cwt. The largest expense items were purchased feed (\$7.00 / cwt), labor (\$2.88 / cwt), and livestock (\$1.04 / cwt). Net farm income from operations was on average \$-.21 / cwt and net farm income was \$-.10 / cwt. The debt to equity ratio was 1.10, the rate of return on assets was -0.02, the rate of return on equity

was -0.08, the operating profit margin was ratio was -0.03. There was no clear association between income, expenses or returns with herd size in 2002. Milk price / cwt was lowest for <500 cows (\$15.81) but other income was highest (42.25 / cwt) resulting in the highest total income (\$19.24 / cwt) and net farm income \$0.57 / cwt. Milk price, total income, total expenses increased with production level. net farm income was highest for medium production level.

Key Words: Dairy, Financial, Management

T265 Factors affecting death losses in DHI holstein herds. L. O. Ely* and J. W. Smith, *University of Georgia, Athens.*

Dairy cow death losses are a significant economic loss for U. S. dairy farmers. This study examines the effect of several factors (yr, region, month of the yr, herd milk production level, and herd size) and the interaction of these factors on death losses in DHI Holstein herds. DHI herd summary records for the years 1999 through 2002 were sorted and classified by yr, region (Northeast, Midwest, Midsouth, South), month, milk production level (low[5443 to 7258 kg], medium [7258 to 9072] and high [>9072]), and herd size (small[<100 cows], low medium [100 to 149], high medium [150 to 299] and large [>300]). Monthly death loss

percent (MDL) was calculated as the number of cows reported died per month / total cows in the herd per month *100. Least squares means for MDL were compared by the Tukey option of SAS PROC GLM. The level of significance used was $P < 0.05$. MDL significantly increased each yr from .56 (1999) to .63 (2002). MDL differed significantly across regions with the lowest value in the Northeast (.47) and the highest value in the South (.67). MDL was lowest for high producing herds (.50) and highest for low producing herds (.67). MDL increased significantly from small size (.55) to large size herds (.67). MDL was highest during July to September across all regions. MDL was $< .70$ during all mo in the Northeast. MDL was $> .70$ during Aug and Sept in the Mid-south, ; $> .70$ during Jul, Aug, Sept in the Midwest, and $> .70$ during Aug, Sept, Oct, Nov, Dec, and Jan in the South. The South not only had the highest values but also the longest duration of high death loss. #8805#8804#8805#8804#8805#8805#8805#8805#8805#8805

Key Words: Cows, Died, Dairy Herd

T266 SoutheastDairyExtension.org - An Internet-Based Dairy Website for Southeast US and Beyond. G. W. Rogers*, E. L. Tipton, K. M. Hill, and J. B. Cooper, *The University of Tennessee, Knoxville*.

Dairy Extension personnel in the southern United States need fast access to pertinent dairy-related articles on the Internet. A website, www.SoutheastDairyExtension.org, sponsored by The University of Tennessee Dairy Extension program and the UT Department of Animal Science currently is providing this to dairy producers, Extension personnel, researchers and 4-Her's throughout the Southeast US. This is a database-driven website designed in Microsoft Access as a portal to the vast amount of web-based dairy industry information. Many prominent and information-rich links are being collected and key information from these are stored as database fields. Fields include the title of the information source, URL, author, state/country, year and a brief excerpt. Keywords, topic and subtopics (also fields) are assigned to each link. Topics pertinent to the Southeast, such as heat stress and heifer raising are featured. Other current topics include economics/marketing, facilities, genetics, grazing systems, health, mastitis/milking, nutrition, reproduction, waste management, and youth. Links include published dairy science papers, popular press articles, Internet-only information, and industry publications. Dairy statistics are available for twelve southern states as well as contact information for Dairy Extension personnel. Tip of the Month and Spotlight are two features on the home

Teaching/Undergraduate and Graduate Education: Teaching

T268 Comparison of evaluation methods for placement in a freshman equitation course. K. Bennett-Wimbush* and S. Porr, *Ohio State University, Agricultural Technical Institute, Wooster*.

The skill level of students enrolling in college riding courses is varied. It is often necessary to evaluate and rate students based on their reported previous riding experience and observed skills in order to place them in an appropriate riding group. This insures a more homogenous student group which should facilitate learning and skill development. The objectives of this study were to gather information on past riding experiences of college students enrolled in an equine science major and compare an instructor evaluation method of riding skills to a student self-evaluation method. One hundred and fifteen students were surveyed and evaluated over a three year period. Students completed a three page questionnaire with the last question asking them to rate their riding skills (SE) as one of the following: Pre-Beginner (1), Beginner (2), Advanced Beginner (3), Intermediate (4), Advanced-Intermediate (5), Advanced (6) or Professional (7). The course instructor then performed a mounted evaluation (IE) of each student using the same evaluation levels without knowledge of the SE. Differences in ratings between SE and IE were determined by Chi square analysis. Additionally the difference in means was analyzed using Proc Means, SAS. Students reported having an average of 7.9 years of riding experience. SE ratings were higher ($p < .01$) than IE. More students rated themselves Advanced-Intermediate (34.86%) while the most common rating from IE was Intermediate (29.36%). SE yielded .92% (1), 8.26% (2), 11.92% (3), 25.69% (4), 34.86% (5) and 11.93% (6). The SE and IE were in agreement for approximately 38% of the students, while 45% of the surveyed students overrated their riding ability compared to the IE, 11% of the students underrated their ability and 6%

page that are updated regularly. A fast-results keyword search is embedded in this application. To keep the site up-to-date, visitors can suggest new links by clicking the "Suggest Link" button that is on each page. They may also submit additional suggestions and content by using an on-line form provided at the site. UT Extension professionals are able to submit all information for each link to this database via a user-friendly form, often by cutting and pasting from an actual Internet-based document.

Key Words: Dairy, Extension, Internet

T267 Association between bulk tank milk urea nitrogen and DHI production variables in California dairy herds. G. E. Higginbotham*¹, W. R. VerBoort², and J. E. P. Santos³, ¹*University of California Cooperative Extension Fresno/Madera Counties, CA*, ²*California DHIA Fresno, CA*, ³*School of Veterinary Medicine, University of California, Davis, Tulare*.

A retrospective study from January, 2001 to December, 2003 was conducted using data from DHI monthly tests to investigate the relationship between daily bulk tank milk urea nitrogen (MUN) concentration and selected DHI production variables from selected Holstein (N=40) and Jersey (N=31) herds located in the central valley of California. Average herd size and rolling herd average (RHA) for milk were 1,123 cows and 10,106 kg, respectively, for Holstein herds, and 730 cows and 7,412 kg, respectively, for Jersey herds. Data were analyzed using regression analyses and the MIXED procedure of the SAS (2001) program. Concentrations of MUN averaged 12.2 and 12.1 for Holsteins and Jerseys ($P=0.34$). Concentrations of MUN were negatively correlated with percentage of casein and true protein ($P < 0.001$) in milk for Holsteins and Jerseys, but the relationships were weak ($r^2 < 0.036$). Bulk tank MUN was not associated with average milk yield per cow ($P=0.11$). However, MUN was negatively correlated with true protein ($r^2=0.0033$; $P < 0.001$) and casein ($r^2=0.0034$; $P < 0.001$) in milk of Holsteins and Jerseys ($r^2=0.027$; $P < 0.001$). Time of season effected concentrations of MUN being significantly ($P < 0.001$) lower during the winter for both Holstein and Jersey herds and significantly ($P < 0.001$) higher during months of heat stress. Test day somatic cell count (SCC) as mean SCC and as linear score showed a negative non-linear relationship with MUN for both breeds.

Key Words: MUN, DHI, Dairy

of the students failed to rate their skills. This supports the use of instructor evaluations of student self-evaluations for proper placement in riding classes.

Key Words: Student Survey, Evaluation, Horse-Back Riding

T269 Integrating leadership, communications, and service learning education to prepare future leaders in the animal sciences. D. R. Brink*, L. D. Moody, and B. S. VanDeWalle, *University of Nebraska, Lincoln*.

Leadership and communications are very beneficial areas of study for Animal Science students. These areas have been included in a program at the University of Nebraska called the Animal Science Leadership Academy (ALA). The program is lead by a professor of Agricultural Leadership Education and Communication and a professor of Animal Science with the assistance of a graduate student. In ALA, there are many different activities for students to obtain leadership experience in business and industry. In the first semester of ALA, students shadow professionals in three different career options, develop a professional presentation and a portfolio of their professional development. Furthermore, as freshmen, ALA students attend the ASAS and ADSA Midwestern Sectional Scientific Sessions. During the second semester, ALA students learn about service learning and develop individual and group service-learning projects. During the third and fourth semesters of ALA, students implement their service learning proposals while also attending sessions focusing on internships and leadership development plans for the remainder of their undergraduate study. In four, 1-credit hour courses a variety of methods are used. Class projects and papers

are designed to build experience for future careers and to create network contacts for future opportunities. Ideas and projects are developed in groups to build communication and interpersonal skills, helpful in a future work environment. Guest speakers provide business and industry perspectives on leadership and communications topics. A survey of ALA students indicated job shadowing was the most beneficial activity of ALA and students agreed they were able to demonstrate leadership

within their classes and student organizations. The partnership of faculty from different departments, business and industry professionals, and students in ALA provides a unique opportunity for Animal Science students to be prepared for leadership positions.

Key Words: Undergraduate, Leadership, Education

Dairy Foods: Chemistry

T270 Storage stability of lutein in cheddar cheese. S. T. Jones*, K. J. Aryana, and J. N. Losso, *Louisiana State University, Baton Rouge.*

The etiology of age-related macular degeneration (AMD) is complex; however, risk factors include genetic and environmental stimulus. As standard therapies for macular degeneration are limited, costly, and often associated with undesirable pathological side effects, the role of nutrition in protecting against AMD is intensively under scientific consideration. Lutein (3,3-dihydroxy- α -carotene) has been identified as a dietary strategy that can delay the onset of AMD. However, available food sources of lutein contain small amounts of lutein. Food fortification with lutein extract has been identified as a low budget prescription to prevent the onset and/or progression of AMD. The objectives of this study were to 1) incorporate various amounts of lutein into cheddar cheese; 2) analyze the stability of lutein during the cheese aging process; and 3) examine the color, pH, and microbiological profile of the cheddar cheese during storage. Lutein, extracted from corn was added to cheddar cheese in quantities of 1 mg, 3 mg, and 6 mg. Measurements of the lutein stability were carried out by HPLC using a YMC C₃₀ carotenoids column. Microbiological analyses of cheese samples included counts using SPC, Coliform, and Y/M Petrifilm. The attributes studied on the cheese were color and pH. The color attribute a* ($p < 0.05$) was significantly different among the treatment and control groups; however no significant difference were observed in L*, b*, and pH values. A significant difference ($p < 0.05$) among 1 mg, 3 mg, and 6 mg treatments were observed in the SPC with respect to the control. The cheese samples were found not to have any coliforms (<10 cfu/g) and Y/M (<10 cfu/g). HPLC data showed quantitative recovery of lutein during the storage period and no lutein degradation products were identified. These results indicate that lutein, a functional food with purported ability to prevent or reduce the onset of macular degeneration; can be added to cheese as a value-added product.

Key Words: Lutein, Cheese, Age-Related Macular Degeneration

T271 Physical properties of κ -casein stabilized emulsions. R. Richter, P. Ungkuraphinunt*, A. Gerung, and G. Perez-Hernandez, *Texas A&M University, College Station.*

The objective of this study was to determine the physical properties of emulsions stabilized with κ -casein. κ -casein was separated from acid casein using ion-exchange separation (Cayot et al. 1992). Emulsions containing 0.3% κ -casein and 3% butteroil were heated to 65°C and homogenized at 20, 60 and 100 MPa. Particle size distribution, rheological properties, heat stability, and the effect of rennet on the coagulation properties of the emulsions were studied. Storage stability was determined by measuring the particle size at the top and bottom of emulsions after 1, 7 and 14 days of storage. Particle sizes (dvs) of the emulsions were 0.738, 0.291 and 0.115 μ m for emulsions homogenized at 20, 60 and 100 MPa respectively. The homogenization pressure did not affect the viscosity of the emulsions, the average viscosity was 1.20 cP and emulsions had a Newtonian behavior. The addition of rennet caused the mean viscosity to increase from 1.20 to 3.74 cP. Significant differences in particle size were not found in the emulsions after heating. Emulsions homogenized at 100 MPa were more stable than emulsions homogenized at 20 and 60 MPa during the storage period. κ -casein can be used to prepare stable emulsion with butteroil.

Key Words: κ -Casein, Emulsion Stability, Physical Properties

T272 Probiotic, fiber fortified, fat free plain yogurt. K. J. Aryana*, *Louisiana State University Agricultural Center, Baton Rouge.*

Probiotic bacteria exert benefits on the gastrointestinal health. High fiber intakes lower the risk of coronary heart disease and certain cancers. The objective was to determine whether or not the incorporation of a combination of probiotic bacteria and fibers impact the physico-chemical and sensory characteristics of fat free plain yogurt. Six different fibers namely Fibergum, Fibersol, Benefiber, Hydrobind, QC-40 and Inulin (ST-Gel) were incorporated at the rate of 1% w/v separately in the yogurt mixes. The total solids were kept constant in the control with non fat dry milk. Yogurt mixes were homogenized, batch pasteurized, cooled and yogurt culture (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) was added. This was immediately followed by further inoculation of the mix with a probiotic culture containing *Lactobacillus acidophilus*, *Bifidobacterium*, and *Lactobacillus casei*. The inoculation rates with probiotic bacteria were 0, 0.02% v/v mix. The yogurt attributes studied were syneresis, viscosity, pH, color (L*, a*, b*), sensory flavor, body and texture and appearance. Yogurts manufactured with Hydrobind exhibited significantly ($p < 0.05$) the least amount of syneresis (released whey) followed by Benefiber. The use of the remaining fibers resulted in syneresis which were not significantly different from the control. Yogurt manufactured with Hydrobind was significantly ($p < 0.05$) the most viscous compared to the control yogurt and yogurts with other fibers. The pH of the yogurts were not significantly ($p < 0.05$) impacted by the incorporation of the above mentioned fibers. Yogurts with Fibersol, Benefiber and QC-40 had significantly ($p < 0.05$) higher L* (Lightness) values compared to the other yogurts. Significantly highest a* and b* values were recorded for yogurts manufactured with Hydrobind and Benefiber respectively. Flavor and body and texture scores for yogurts with ST-Gel, QC-40 and Fibersol were not significantly ($p < 0.05$) different from the control. The appearance scores of yogurts with Fibergum and ST-Gel were high and did not differ significantly ($p < 0.05$) from the control. Probiotics along with different fibers favorably impacted different attributes of fat free yogurts.

Key Words: Health, Fermented, Dairy

T273 Fat free plain set yogurts fortified with minerals. K. Achanta*¹, K. J. Aryana², and C. Boeneke², ¹*Louisiana State University*, ²*Louisiana State University Agricultural Center.*

The health benefits of various minerals are well documented in literature. Whether or not the incorporation of various minerals impacts the physico-chemical characteristics of yogurt is not clearly understood. Seven different minerals namely, iron, magnesium, zinc manganese, molybdenum, chromium and selenium were incorporated separately into the yogurt mixes at 25% of their respective recommended dietary allowances. The various attributes studied on the yogurts were viscosity, color (L*, a*, b*), pH, syneresis, flavor, body, texture and appearance. No significant difference was observed in viscosity, color (L*, a*, b*), pH, syneresis, body, texture and appearance for yogurts fortified with minerals when compared to the control yogurt. The flavor scores of selenium fortified yogurt were significantly lower from that of the control yogurt. Fortification of yogurts with the above mentioned minerals can be accomplished without adversely affecting the product characteristics.

Key Words: Health, Dairy, Fermented

T274 Effect of emulsifying salts on texture of pasteurized process Cheddar cheese. N. Shirashoji^{*1,2}, J. J. Jaeggi², and J. A. Lucey², ¹*Food Research & Development Laboratory, Morinaga Milk Industry Co., Japan*, ²*University of Wisconsin, Madison*.

A detailed understanding of the influence of various emulsifying salts (ES) on process cheese functionality is important to control product quality and its end-use application. Model process cheeses were made in preliminary trials from 3-4 months old Cheddar cheese with trisodium citrate (TSC), tetrasodium pyrophosphate (TSPP) or polyphosphate salts (1-3%) that was heated at 80°C for 2 min using a bench top blender. Hot melted cheese was poured into pouches and stored at 3-5°C for 7 d. Small amplitude oscillatory rheology (SAOR) was used to study the rheological properties using a temperature sweep (frequency 0.08 Hz, strain 0.5%) from 5-85°C at a heating rate of 1°C/min. Melting properties of process cheese were measured by UW-Meltprofler. Uniaxial compression of cheese was determined by compression to 20% of original height. Acid-base titration method was used to determine the concentration of residual insoluble calcium phosphate. Initial results from these model cheeses indicated that the storage moduli values between 40 to 85°C of cheese made with polyphosphate were higher than those with TSC, which had excellent meltability. A low concentration of TSPP resulted in cheese that had greatly reduced melt. Uniaxial compression showed that cheese with added polyphosphate had higher hardness and lower adhesiveness values than cheese made with TSC. Titration curves of process cheese made with TSC resulted in a reduction in the buffering peak at pH 4.8 as the concentration of ES increased. The buffering peak at pH 4.8 is caused by residual insoluble calcium phosphate. This buffering peak shifted to a lower pH value (pH 4.04.2) as the concentration of added polyphosphate increased. Currently pilot plant scale cheese trials with these ES and various heat treatments are being performed and will be reported.

Key Words: Texture, Process Cheese, Melt

T275 Probiotic, fat free, no sugar added ice cream. M. Summers^{*} and K. J. Aryana, *Louisiana State University Agricultural Center, Baton Rouge*.

Probiotic bacteria exert benefits on the gastrointestinal health. The objective was to determine whether or not the incorporation of probiotic bacteria impacts the physico-chemical and sensory characteristics of fat free no sugar added ice cream. A fat free, no sugar added ice cream mix was homogenized, vat pasteurized, cooled, and aged. Prior to freezing, vanilla flavor was added. The mix was inoculated with a probiotic culture containing *Lactobacillus acidophilus*, *Bifidobacterium* and *Lactobacillus casei*. Mixes were inoculated at rates of 0, 0.002, 0.02 and 0.2 %v/v. Immediately after inoculation the mixes were frozen. The attributes studied on the mixes were viscosity and pH. Attributes studied on the ice creams were color, meltdown time for first 15 ml, meltdown ml after 60 minutes, and sensory flavor, body and texture. The probiotic ice creams had significantly higher L* and b* values compared to the control. The a* values for the probiotic ice creams were significantly lower than the control. There were no differences in L*, a*, and b* values among the probiotic ice creams. The pH of the control was significantly lower compared to the probiotic ice creams. There were no significant differences in pH among the probiotic ice creams. There was no significant difference in the meltdown time for first 15 ml, meltdown ml after 60 minutes, sensory flavor, and body and texture of the ice creams. Incorporation of probiotic bacteria impacted some of the physico-chemical characteristics of fat free no sugar added ice cream.

Key Words: Health, Dessert, Dairy

T276 Effect of insoluble calcium phosphate on cheese functionality. J. Choi^{*1}, D. S. Horne², M. E. Johnson¹, and J. A. Lucey, ¹*University of Wisconsin, Madison*, ²*Charis Food Research, Scotland*.

We hypothesized that loss of insoluble Ca from casein could be responsible for softening and flow of cheese. To test this hypothesis, skim milk was directly acidified with lactic acid to pH 6.0, 5.8, 5.6 and 5.4. In another trial, EDTA (0, 2, 4, and 6 mM) was added to skim milk, and milk was directly acidified to pH 6.0. Both types of milks were processed into cheese. The proportion of insoluble Ca was determined by acid-base titration method. Dynamic low amplitude oscillatory rheology was used

to measure the viscoelastic properties of cheese during heating from 5 to 80°C. To reduce the effect of proteolysis, viscoelastic properties were measured 10 h after pressing. The moisture content in all the cheeses was the same (55%), as cheesemaking procedures were modified to obtain similar moistures. The loss tangent maximum (MaxTan) increased (i.e. more flow) during heating, and for cheese made from milk preacidified to pH 6.0, 5.8, 5.6, and 5.4 it was 1.5, 2.9, 4.0, and 4.8, respectively. MaxTan of cheese made from milk with 0, 2, 4, and 6 mM EDTA were 1.5, 1.9, 2.5, and 3.4, respectively. The cheese pH was 5.7, 5.6, 5.4, and 5.3 for cheeses made with milk acidified to pH 6.0, 5.8, 5.6, and 5.4, respectively, and all cheeses from EDTA trials had the same pH (5.7). When the proportion of insoluble Ca in cheese made from milk acidified to pH 6.0 was set as 100%, there was 85, 71, 63% residual insoluble Ca in cheese made at pH 5.8, 5.6, and 5.4, and 96, 83, 80% for 2, 4, and 6 mM EDTA cheese, respectively. Preacidification of milk resulted in a reduction in total Ca and decreased the proportion of insoluble Ca and both could contribute to the increased softening and flow observed in lower preacidification cheeses. Addition of EDTA reduced the proportion of insoluble Ca while there was a only slight reduction in total Ca and pH was constant. The greatly increased melt with higher levels of EDTA was due to the reduction in insoluble Ca.

Key Words: Insoluble Calcium Phosphate, Cheese Functionality, Loss Tangent

T277 Texture and microstructure of full fat and low fat Cheddar cheeses fortified with chitosan. K. J. Aryana^{*} and M. C. Beck, *Louisiana State University Agricultural Center, Baton Rouge*.

Chitosan is a fat absorbing fiber. Adding chitosan to full fat and low fat Cheddar cheeses could make it possible to enjoy the advantages of fat (texture, flavor, mouthfeel) and avoid the disadvantage by preventing fat absorption in the intestine. The objective was to elucidate whether or not incorporation of chitosan in full fat and low fat Cheddar cheeses influences the texture and microstructure of cheese. Two types of chitosan namely granular and 90% high density were incorporated during cheese making at 0, 0.5 and 1.5% w/w fat in cheese. Texture was determined using a TA.XT plus texture analyzer and the microstructure was determined by scanning electron microscopy. The fracture stress and strain of the full fat and low fat control cheeses were significantly (p<0.05) higher compared to the cheeses with chitosan. Incorporation of chitosans at the highest concentrations resulted in cheeses with compact surface microstructures compared to the control. Chitosan incorporation in cheese at 1.5% w/w fat impacted the texture and microstructure of full and low fat Cheddar cheeses.

Key Words: Fat, Dairy, Health

T278 Quantification of volatile flavor compounds in fresh and different off-flavor lowfat milks. L. L. Francis, D. H. Chambers, I. J. Jeon, and K. A. Schmidt^{*}, *Kansas State University, Manhattan*.

Various chemical compounds contribute to the naturally pleasant flavor of milk, however with time and unwanted reactions, flavor loss is inevitable. This study was done to quantify and compare chemical compounds in "various flavors" of lowfat milk for identification of critical compounds that contribute to fresh milk flavor. Fresh milk (2d) was used to purposely prepare altered milks such as light oxidized and high acid. Lacks freshness was a 2 wk prior production milk maintained at 4°C in the dark. For SPME analysis, 75µm Carboxen/PDMS fiber sampling at 60°C for 30 min was used to collect volatile compounds in the milk headspaces which were subsequently analyzed by GC-FID for quantification. In addition all milks were analyzed for compositional contents and microbial counts. This experiment was replicated twice. Results from this study provide evidence that fresh milk flavor cannot be defined by the concentration of pentanal, hexanal, 2-heptanal, benzaldehyde, 2-butanone, and octanal only. Trends showed that light oxidized milk had a lower concentration of octanal and a higher concentration of hexanal than did fresh milk. When comparing oxidized milks exposed to light (200 ft candles) at various times (1 and 3 h), pentanal and 2-butanone concentrations increased as light exposure time increased. High acid milk possessed higher concentrations of benzaldehyde and 2-butanone, but had a lower concentration of octanal than did fresh milk. Lacks freshness milk had a higher concentration of pentanal and a lower concentration of octanal than did the fresh milk. All milks had similar

fat, total solids, and viscosity values. The lacks freshness and high acid milk had higher total plate counts than did the other milks which were considered equivalent. For this study fresh milk had a higher octanal concentration than did the off-flavored lowfat milks, which may suggest that octanal or a defined ratio of octanal to another compound is an important contributor to fresh milk flavor and, thus deserves further study.

Key Words: Milk, Flavor, Compounds

T279 Serving temperature effects on milk flavor, milk aftertaste, and volatile compound quantification in nonfat and whole milk. L. L. Francis, S. H. Kong, D. H. Chambers, I. J. Jeon, and K. A. Schmidt*, *Kansas State University, Manhattan.*

Teenagers find the flavor and aftertaste of milk more acceptable when milk is served cold. However, describing the flavor and aftertaste of milk and correlating it to its chemical composition have not been reported. The objectives of this study were to describe the flavor and aftertaste of milk, and quantify the headspace volatiles of nonfat and whole milk as a function of serving temperature (4, 10, and 15°C). The descriptive panel results indicated that as serving temperature increased milk flavor was described as more flat or more astringent. Nonfat milk flavor was rated as having greater sour aromatics, and being more chalky, cardboard, flat, bitter, and metallic but less sweet than the whole milk flavor. Characterizing milk aftertaste at 15 s after swallowing indicated that nonfat milk had more sour, cardboard, and cooked traits than did the aftertaste of whole milk. Characterizing milk aftertaste at 90 s after swallowing indicated that the nonfat milk was less sweet, but had more cardboard and cooked traits than whole milk. With time, aftertaste ratings decreased for sweet, cooked, and fat whereas cardboard and processed aftertaste ratings remained similar. The sour aromatics aftertaste ratings were no longer significant at 90 s. Headspace volatile compounds of milk samples served at 4 and 15°C were quantified using SPME analysis, 75 µm Carboxen/PDMS fiber sampling, done at 60°C for 30 min and then analyzed by GC-FID for quantification. Serving temperature was not significant, but nonfat milks had a higher concentration of hexanal but lower concentrations of 2-heptanone, heptanal, and benzaldehyde than did the whole milk. Correlating the headspace compounds with flavor descriptors, hexanal, which has been associated with cardboard flavors, was higher in the nonfat milk. These data provide evidence that the fat contributes to the flavor and aftertaste traits of milk. For this study milk composition was more influential to milk aftertaste as opposed to serving temperature.

Key Words: Aftertaste, Milk, Flavor

T280 Evaluation of pH stability in different types of heat-treated fluid and manufactured milk products during refrigerated storage. C. O. Maduko*¹, R. Shewfelt¹, J. Frank¹, and Y. W. Park², ¹University of Georgia, Athens, ²Fort Valley State University Agricultural Research Station, Fort Valley, GA.

Heat-induced changes in pH due to shifts in the milk salt equilibrium are largely reversible, while the re-establishment of the equilibrium on cooling is slow. Heat treatment reduces the concentrations of soluble phosphates as well as soluble and ionic calcium. Heat treatment causes the precipitation of soluble calcium to colloidal calcium phosphate, which greatly influences the stability of pH and casein micelle structure in the milk. Ten different types of commercial milk products: pasteurized cow fluid (PCF), cow evaporated (CE), cow skim fluid (CSF), cow skim powdered (CSP), cow whey (CW), pasteurized goat fluid (PGF), goat evaporated (GE), goat milk protein concentrates (GPC), soy fluid (SF) and soy powdered (SP) milks were purchased to study the pH stabilities of the milk products during two weeks storage at 4 and 13°C refrigeration and 22°C room temperature. Evaporated and powdered milks were reconstituted by adding 50 and 87.5% (v/v) deionized water to the products, respectively. All milk groups were divided into three subgroups as heat treated by pasteurization (63°C for 30 min), sterilization (121°C for 20 min), and 22°C room temperature, then pHs were determined. The range of initial pHs for PCF and CE were 6.8-6.9 and 6.4-6.5, then decreased to 6.50-6.75 and 5.97-6.16 after heat treatment at 1st day refrigerated storage. This may be attributable to heat-induced acid production from lactose degradation and precipitation of tricalcium phosphate. From day 3 to 7, there were gradual increases in pH for PCF, CE, PGF and GE by 0.05-0.67 for bovine and 0.03-0.29 for caprine products. The lowest pH reached at day 9 for fluid milks,

where a more drastic pH declines were observed in the milks stored at 4°C compared to those stored at 13°C. The pH stabilities of CE, SCP, SCP, CW, GE were better than the corresponding fluid milks. The SF and SP showed the highest pHs (above 7.0), while the GPC revealed the lowest values. Heat-treated fluid milks had better pH stability at 13°C storage than at 4°C due to the minimized effect of casein dephosphorylation and changes in phosphate equilibrium which would occur at lower temperature.

Key Words: pH Stability, Milk Products, Heat Treatment

T281 Use of long-chain polyphosphates for shelf-life extension of processed cheese spreads. L. Varga* and S. Orbán, *Department of Dairy Science, Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.*

The effect of a food-grade long-chain polyphosphate mixture (JOHA HBS sodium polyphosphate glassy, 69±1% P₂O₅) on the growth and survival of spoilage microorganisms during storage in an experimental processed cheese spread formulation containing 55% moisture and 57% fat in dry matter was evaluated. The emulsifying salt was added to the cheese blend at a concentration of 0.5% or 1.0%. A control product was also manufactured, which contained monophosphate instead of polyphosphate as emulsifying salt, with all other ingredients being identical to those in the experimental processed cheese spread. The finished products were subjected to either accelerated shelf-life testing at 37°C for 10 d or refrigerated storage at 4°C for 120 d. Microbiological analyses (enumeration of viable cell counts, sulfite-reducing clostridia, coliforms, yeasts, and molds), acidity measurements, and sensory tests were performed at regular intervals. The results obtained showed that polyphosphates had a beneficial effect on the shelf life of the processed cheese spread tested in that they significantly reduced (*P* < 0.05) the growth or survival rate of spoilage microorganisms, especially of sulfite-reducing clostridia. Polyphosphates also beneficially influenced the sensory, including textural properties of the experimental processed cheese spread. All the samples containing less than 1% polyphosphate showed signs of butyric blowing significantly earlier (*P* < 0.05) during both accelerated shelf-life tests and regular refrigerated storage than did products fortified with 1% polyphosphate. In conclusion, the suitability of the long-chain polyphosphate formulation tested for shelf-life extension of pasteurized processed cheese spreads was demonstrated.

Key Words: Polyphosphate, Processed Cheese, Shelf Life

T282 Seasonal variations in chemical composition of water buffalo milk. F. Lee*¹, J. Page², S. Gokavi¹, and M. Guo¹, ¹University of Vermont, Burlington, ²Page & Pedersen International, Ltd., Hopkinton, MA.

Production of water buffalo milk yogurt, fresh Mozzarella and other products was established in Vermont and is projected to increase steadily in the next several years. However, information on chemical composition and its seasonal variation of year-round bulk-collected water buffalo milk is limited. The objective of this study was to analyze the chemical composition of commingled raw water buffalo milk from the creamy for 12 months to provide fundamental information for yogurt and cheese manufacture. The breeds of the water buffalos were mostly Riverine, with a mix of Murrah, Nili-Rivi and Jafrabadi, and their diet included a mixture of corn silage, baylage and palletized supplements. Samples were collected on the second week of each month, beginning in November, 2002, and analyzed for total solids, fat, lactose, crude protein, ash, specific gravity, minerals and pH. Chemical composition and pH of the water buffalo milk varied slightly during the period. The contents of total solids, fat, lactose, crude protein, ash, and specific gravity were 17.86 ± 0.74, 7.20 ± 0.50, 4.61 ± 0.04, 5.02 ± 0.12, 0.92 ± 0.01, and 1.0339 ± 0.0017 %, respectively. Ranges for these composition were 16.39-18.39, 6.57-7.99, 4.49-4.74, 4.59-5.37, 0.91-0.92 and 1.0317-1.0380, respectively. Mineral contents of Ca, P, K, Mg, Na and Zn were 1798.89 ± 286.97, 1216.76 ± 199.03, 843.72 ± 141.87, 337.20 ± 80.92 and 7.48 ± 3.11 mg/kg, respectively, and remained steady throughout the year. Value of pH was 6.85 ± 0.06, with a range of 6.76-6.98. Content of total solids was higher in the months of November thru March (18.46 ± 0.19 %) when compared to April thru October (17.34 ± 0.62 %). Fat content was higher in the months of September thru January (7.66 ± 0.27 %) compared with February through August (6.80 ± 0.20 %). Crude protein level was higher from November to May (5.14 ± 0.18

%). The data showed that variations in the chemical composition of the bulk water buffalo milk occurred during the period of this study.

Key Words: Buffalo, Milk, Composition

T283 Relationship between cholesterol and fat contents of commercial dairy products. Á. Kovács¹, L. Varga*², R. Dulicsek¹, J. Szigeti², and Z. Herpai², ¹PharmaFood Inc., Pécs, Hungary, ²Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.

The aims of this study were to determine the cholesterol and fat contents of a wide range of dairy products, and to find a relationship between these two compositional attributes. Thirty-three varieties of commercial fluid milks, hard and semi-hard cheeses, condensed and dried milks, cream products, butters, buttercreams, and fermented milks were purchased from food stores located in the western part of Hungary and were then analyzed for fat and cholesterol using the Roese-Gottlieb method and the direct saponification-gas chromatographic method, respectively. Cholesterol-to-fat ratios were also calculated from the values obtained. A high correlation ($r = 0.983$) was found between cholesterol and fat concentrations. Butters and buttercreams had the highest fat and cholesterol levels of the 33 varieties of dairy products tested. The nonfat varieties of dried, fermented, and fluid milks showed largely increased cholesterol-to-fat ratios as compared with the other products, which must have been due to the mechanical damage caused by cream separation to fat globule membranes because the membrane-bound cholesterol thus released remained in skim milk at a higher proportion than fat did. The results of this study can be used for various purposes such as quality control of milk products, food labeling, consumer information, and development of new dairy foods. They may also be needed when assessing fat and cholesterol intakes in epidemiological studies aimed at investigating the relation between diet and health, when formulating diets for population groups with special requirements, or when establishing dietary guidelines for the general public according to health concerns.

Key Words: Cholesterol, Fat, Dairy Product

T284 Development of technology for manufacturing lactose-free fermented milks. J. Szigeti, Á. Krász, and L. Varga*, Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.

Lactose intolerance is common in adult populations worldwide except for peoples with a northern European genetic background. We have developed a technology for production of lactose-free fermented dairy products. The protein content of the process milk was increased whereas its lactose level was decreased by addition of milk protein concentrate. The raw material was then inoculated with the starter cultures selected (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* or *S. thermophilus* and *L. acidophilus*), and the lactic acid produced during the initial stages of fermentation was neutralized using a proper mixture of sodium hydroxide and potassium hydroxide. Thereafter fermentation was run according to normal commercial practice. The lactose and glucose levels of the fermented milks thus produced were negligible and their galactose content was moderately or highly reduced, depending on the starter organisms used. The finished products did not differ in texture or flavor from regular fermented milks.

Key Words: Fermented Milk, Lactose, Galactose

T285 Rheological and light scattering properties of cottage cheese-type gels made under different gelation rates. M. Castillo*^{1,2}, J. A. Lucey¹, and F. A. Payne², ¹Department of Food Science, University of Wisconsin, Madison, ²Department of Biosystems and Agricultural Engineering, University of Kentucky, Lexington.

The study of milk coagulation by a combination of acidification and rennet (i.e. mixed gels) has received very little attention when compared to rennet-induced coagulation. In cottage cheese, for example, a little rennet is sometimes added to alter the gelation characteristics. Monitoring coagulation by an objective device when cheese is made by many different manufacturing conditions would be useful to control the consistency at cutting and thereby improve the quality of cottage cheese. Gels made at different gelation rates were investigated by a randomized factorial design. Gels were made with a low rennet concentration at three

different temperatures and three different starter concentrations. Gel formation was monitored using infrared light (880 nm) backscatter and dynamic small amplitude oscillatory rheology. Increasing incubation temperature or inoculum concentration enhanced the rate of pH reduction resulting in faster network formation. When coagulation rate increased, the gels became more viscous (i.e. higher loss tangent) and less stiff (i.e. lower storage modulus). The backscatter parameter, t_{min2} , and the rheologically-determined gelation time were highly correlated ($r = 0.992$, $P < 0.0001$) but not significantly different ($P > 0.36$), suggesting that they corresponded to the beginning of gel firming. Activation energy of network formation estimated by light backscatter decreased significantly with increasing starter concentration, which could be related to a reduction in the energy barrier against aggregation caused by enhanced acidification rate.

Key Words: Rheology, Light Backscatter, Cottage Cheese

T286 Influence of natural cheese characteristics on process cheese functionality: Unmelted and melted properties. A. C. Biswas*¹, R. Kapoor², P. Upreti², L. Metzger², and K. Muthukumarappan¹, ¹Department of Ag. & Bio. Engr., South Dakota State University, Brookings, ²Department of Food Science and Nutrition, University of Minnesota, St. Paul.

Four treatments of Cheddar cheese with two levels (high and low) of calcium (Ca) and phosphorus (P), and two levels (high and low) of residual lactose were manufactured. Each treatment was subsequently split prior to the salting step of cheese manufacture and salted at two levels (high and low) for a total of eight treatments. The eight treatments included: High Ca and P, High lactose, High S/M (HHH); High Ca and P, High lactose, Low S/M (HHL); High Ca and P, Low lactose, High S/M (HLH); High Ca and P, Low lactose, Low S/M (HLL); Low Ca and P, High lactose, High S/M (LHH); Low Ca and P, High lactose, Low S/M (LHL); Low Ca and P, Low lactose, High S/M (LLH); and Low Ca and P, Low lactose, Low S/M (LLL). At two months of ripening each treatment was used to manufacture process cheese food using a twin-screw Blentech process cheese cooker. All of the process cheese food formulations were balanced for moisture, fat, and salt. Texture and melting characteristics of the process cheese were evaluated with several techniques including the modified Schreiber test, melt profile test, and texture profile analysis (TPA). There was a significant ($P < 0.05$) decrease in melt area and softening rate and an increase in softening temp and TPA-hardness in the high Ca and P treatments (HHL, HLH, HHL, and HHH) as compared to the low Ca and P treatments (LHH, LHL, LLH, and LLL). Additionally, a significant ($P < 0.05$) decrease in melt area and softening rate and an increase in softening temp and TPA-hardness was observed when the high salt treatments (HLH, HHH, LHH, and LLH) were compared to the low salt treatments (HLL, HHL, LHL, and LLL). No significant ($P > 0.05$) difference was observed in the melt characteristics and hardness of the high lactose treatments (HHH, LHH, HHL, and LHL) as compared to the low lactose treatments (HLH, LLH, HLL, and LLL). This study demonstrates that the characteristics of natural cheese (calcium and phosphorus content and salt/moisture ratio) used in process cheese manufacture have a significant impact on process cheese functionality.

Key Words: Process Cheese, Calcium, Melt

T287 Effect of aging on the proteolytic and rheological properties of Mennonite-style cheeses from Chihuahua, Mexico. D. L. Van Hekken*¹, M. H. Tunick¹, P. M. Tomasula¹, F. J. Molina-Corral², and A. A. Gardea², ¹USDA, ARS, ERRC, Wyndmoor, PA, ²CIAD, Cuauhtemoc, Chihuahua, Mexico.

The proteolytic and rheological properties of semi-hard Mennonite-style cheeses, made from raw or pasteurized milk, were measured over 16 wk of 4°C storage to evaluate the changes that occurred during aging. Samples, obtained from four different Chihuahua cheese manufacturers (two used raw milk and two used pasteurized milk), were collected within days of manufacture and stored. Degree of proteolysis (SDS-PAGE) and rheological (small amplitude oscillatory strain, torsion, and texture profile analyses) properties of the cheeses were measured at 4 wk intervals. Over the 16 wk of storage, cheeses made with raw milk produced sufficient gas to disrupt the cheese matrix and severely limit shelf life. The loss of textural integrity in raw milk cheeses was reflected in the greater rate of proteolysis (decrease in α_{S1} - and β -casein with concomitant increase of casein fragments with molecular mass of 22-18

kDa and <14 kDa) and the decrease in shear strain at the point of fracture (ability to withstand deformation). Shear strain of the pasteurized milk cheeses increased with age. While the hardness, cohesiveness, chewiness, and shear stress and shear rigidity at the point of fracture of all cheeses decreased over time, these properties decreased more rapidly and tended to be lower for the raw milk cheeses than the pasteurized milk cheeses. Results indicate that proteolysis and shear strain are good indicators of differences in the cheese matrix between the aging raw milk and pasteurized milk cheeses.

Key Words: Hispanic-Style Cheese, Aging, Rheology

T288 Influence of natural cheese characteristics on process cheese functionality: Dynamic viscoelastic properties. A. C. Biswas*¹, R. Kapoor², P. Upreti², L. Metzger², and K. Muthukumarappan¹, ¹Department of Agricultural & Biosystems Engr., South Dakota State University, Brookings, ²Department of Food Science & Nutrition, University of Minnesota, St. Paul.

Four treatments of Cheddar cheese with two levels (high and low) of calcium (Ca) and phosphorus (P), and two levels (high and low) of residual lactose were manufactured. Each treatment was subsequently split prior to the salting step of cheese manufacture and salted at two levels (high and low) for a total of eight treatments. The eight treatments included: High Ca and P, High lactose, High S/M (HHH); High Ca and P, High lactose, Low S/M (HHL); High Ca and P, Low lactose, High S/M (HLH); High Ca and P, Low lactose, Low S/M (HLL); Low Ca and P, High lactose, High S/M (LHH); Low Ca and P, High lactose, Low S/M (LHL); Low Ca and P, Low lactose, High S/M (LLH); and Low Ca and P, Low lactose, Low S/M (LLL). At two months of ripening each treatment was used to manufacture process cheese food using a twin-screw Blentech process cheese cooker. All of the process cheese food formulations were balanced for moisture, fat, and salt. Dynamic viscoelastic (G' and G'' at $\tan \delta = 1$) characteristics of the process cheese were evaluated using a Viscoanalyzer at 1Hz and 0.5% strain level. There was a significant ($P < 0.05$) increase in both G' and G'' values in the high Ca and P treatments (HHH, HHL, HLH, and HHH) as compared to the low Ca and P treatments (LHH, LHL, LLH, and LLL). Additionally, an increase in G' and G'' values was observed when the high salt treatments (HLH, HHH, LHH, and LLH) were compared to the low salt treatments (HLL, HHL, LHL, and LLL). In the high Ca and P treatments with high lactose (HHL and HHH) a significant ($P < 0.05$) increase in G' and G'' was observed relative to the low lactose treatments (HLL and HLH), whereas in the low Ca and P treatments high lactose significantly ($P < 0.05$) decreased G' and G'' in the high salt treatments and had no effect ($P > 0.05$) in the low salt treatments. This study demonstrates that the characteristics of natural cheese (calcium and phosphorus content, lactose, and salt/moisture ratio) used in process cheese manufacture have a significant impact on process cheese rheological characteristics.

Key Words: Process Cheese, Calcium, Rheology

T289 Quantitative evaluation of light-oxidized off-flavors in reduced fat milk using sensory evaluation and the electronic nose. H.-Y. Chung*¹, J. A. Partridge², and B. R. Harte¹, ¹School of Packaging, Michigan State University, East Lansing, ²Food Science and Human Nutrition, Michigan State University, East Lansing.

Light-oxidized off-flavors in milk can occur when exposed to fluorescent light in retail dairy cases. Photosensitized oxidation of milk proteins and lipids can be initiated by light activation of riboflavin which results in generation of sulfur and carbonyl volatiles. An electronic nose equipped with 12 metal-oxide semiconductor sensors was used to analyze headspace volatiles. Reduced fat (2%) milk in glass bottles was exposed to 0, 2, 4, 8, 12, 24, 36 and 48 hours of fluorescent light (1000 lx) at 5°C. Milk in various packaging (HDPE, HDPE-TiO₂ and PET bottles and paper cartons) was also exposed to fluorescent light for 12 hours. Sensor responses (max dR/R₀) from the electronic nose were correlated to ADSA sensory scores from a trained taste panel, using partial least square (PLS) or multilayer perceptrons (MLP) techniques. Sensory scores of 2% milk in glass bottles decreased continually with increase in light exposure to 24 hours. Milk stored in the better light barriers, i.e. paper cartons and HDPE-TiO₂ bottles, had slightly higher sensory scores than the others, but the differences were not statistically significant. A PLS model based on a 95°C headspace sampler technique had the lowest root mean square error (RMSE) and was a

better fit than 45°C and 70°C, as well as all MLP model temperatures. The PLS approach was to find latent component(s) from electronic nose sensor responses that were also relevant to sensory scores. It was well defined for light-oxidized milk in glass bottles, since higher light-oxidized volatiles gave higher sensor responses and lower sensory scores. Alternatively, MLP was a better model for milk stored in the other packages and exposed to light. The electronic nose has potential to be used to determine light-oxidized off-flavors in packaged milk quantitatively.

Key Words: Electronic Nose, Milk, Light Oxidation

T290 Effect of pre-storage and sterilization on physico-chemical properties of goat milk during storage. A. C. Biswas*¹, A. K. Bandyopadhyay², P. K. Ghatak², and K. Muthukumarappan¹, ¹Dept. of Agricultural & Biosystems Engr., South Dakota State University, Brookings, ²Dept. of Dairy Chemistry, Faculty of Dairy Technology, West Bengal University of Animal & Fishery Sciences, Kolkata, India.

Effect of pre-storage and sterilization (121°C / 1.05 Kgf/cm² pressure for 10 min) on goat milk was determined during cold (5°C) and warm (30°C) temperature storage by evaluating changes in its physico-chemical properties. Three different sterilization treatments, T1 (sterilized on the same day of milking), T2 (stored at 5°C for 24 h and then sterilized) and T3 (stored at 5°C for 48 h and then sterilized) were applied to the goat milk. The sterilized goat milk was then equally stored at 5°C and 30°C respectively and physico-chemical properties, viz. viscosity, surface tension (ST), titratable acidity (TA), pH, free fatty acid (FFA), Tyrosine value (TV), non-protein nitrogen (NPN), and hydroxymethyl furfural (HMF) values were monitored on 0, 15, 30, 45 and 60 days. The experiment revealed significant increase in viscosity, TA, FFA, TV, NPN, and HMF during storage at 5°C and 30°C. In addition, significant difference ($P < 0.01$) in all physico-chemical properties was observed between the treatments (T3 showed significantly higher values compared to T2 and T1), and also for different storage duration. This study elucidated that the increase in pre-storage time at 5°C before sterilization have a significant effect on the physico-chemical properties during storage at different temperatures.

Key Words: Goat Milk, Sterilization, Physico-Chemical Properties

T291 Development of Cheddar cheese for lowering blood cholesterol by phytosterol ester. H. S. Kwak*, H. J. Ahn, S. J. Lee, and J. Ahn, *Sejong University, Seoul, Korea.*

This study was carried out to investigate the effect of phytosterol ester addition on lowering blood cholesterol in cholesterol-reduced Cheddar cheese, which was manufactured with the milk combined with cholesterol-reduced cream and skim milk. After cholesterol reduction process by beta-CD treatment, the cholesterol removal rate was in the range of 91.2 to 92.1%. Amount of short-chain free fatty acid and free amino acids increased with an increase of phytosterol ester addition, and those were significantly different from that of control in all ripening periods. Among neutral volatile compounds, more acetaldehyde and ethanol were produced in control than other compounds in phytosterol ester-added groups. All texture values increased with an increase of phytosterol ester amount during ripening period. In sensory analysis, the scores of rancid, bitterness, Cheddar flavor and off-flavor intensities increased significantly, while texture was decreased during ripening in phytosterol ester-added groups. In animal study, total blood cholesterol lowered 18% with 8% phytosterol ester-added Cheddar cheese, which was significantly different to that of control. The present study indicated that phytosterol ester showed the lowering effect of blood cholesterol when it was added in cholesterol-reduced Cheddar cheese.

Key Words: Phytosterol Ester, Blood Cholesterol, Cheddar Cheese

T292 Crosslinking of beta-cyclodextrin and the optimizing of cholesterol removal in milk by using the crosslinkage. S. H. Kim*, E. M. Han, J. Ahn, and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was performed to crosslink beta-cyclodextrin (beta-CD) and to find the optimum conditions of cholesterol removal using the crosslinked beta-CD in milk. Two different methods were tested using 2.3 mL epichlorohydrin and 2.5 g of adipic acid, and added into containing 250 g of crosslinked beta-CD in NaOH solution. After 24

hr magnetic stirring, the pH of solution raised to 10. The solution was washed with distilled water, and dried for 24 hrs. In a subsequent study, two different crosslinked beta-CDs were used to find the optimum conditions for cholesterol removal in milk. In both, the optimum conditions were 1% beta-CD addition, 10 min stirring time, and 800 rpm stirring speed. The rates of cholesterol removal were 80 and 75% in epichlorohydrin and adipic acid, respectively. In conclusion, the present study showed the possibility of crosslinked beta-CD development and the application to cholesterol removal process in milk.

Key Words: Crosslinking, Beta-Cyclodextrin, Cholesterol Removal

T293 Simple immobilization of beta-cyclodextrin to remove cholesterol in milk and recycling. H. S. Kwak*, S. H. Kim, J. H. Kim, H. J. Choi, and J. Kang, *Sejong University, Seoul, Korea.*

This study was designed to determine the optimum conditions of three different factors (mixing time, mixing temperature, and tube size) in reduction of cholesterol in milk using immobilized beta-CD beads. Immobilized beta-CD glass beads were prepared at different conditions of silanization and beta-CD immobilization reactions. In result, the glass beads (diameter 1 mm) at 20 mM 3-isocyanatopropyltriethoxysilane and 30 mM beta-CD without base showed the highest cholesterol removal rate as 52%. Using above immobilized beta-CD glass beads, the cholesterol removal rate was 51.2% with 6 hrs of mixing time in 7 mm diameter tube at 10°C. After cholesterol removal from milk, the glass beads were washed for cholesterol dissociation and reused. For recycling study, the cholesterol removal rate was 52%, which was mostly same as that using new glass beads. These results indicated that cholesterol removal rate was 52% with beta-CD immobilized glass beads, however, the recycling efficiency was almost 100%.

Key Words: Beta-CD Immobilization, Cholesterol Removal, Recycling

T294 Effects of microencapsulated chitoooligosaccharide addition on cholesterol-reduced milk. H. J. Choi*, J. Ahn, J. H. Hwang, and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was designed to develop microencapsulated chitoooligosaccharide that could be added into cholesterol-reduced milk, and to examine the changes of physical and sensory properties during storage. Coating material was polyglycerol monostearate (PGMS). The efficiency of microencapsulation was 80.08% with 10:1 ratio (w/w) as coating to core materials. When even 0.5% microencapsulated chitoooligosaccharide was added, the L, a, b values and viscosity were significantly different from that of control (uncapsulated chitoooligosaccharide added). In stability measurement of microcapsules, the releases of chitoooligosaccharide were 1.33% and 1.25% in distilled water and cholesterol-reduced milk for 15 day storage at 4°C, respectively. In a sensory analysis, the values of astringency, bitterness, and color were significantly different between control and encapsulated chitoooligosaccharide-added cholesterol-reduced milk for 7 days of storage. The present study indicated that the microencapsulated chitoooligosaccharide showed a high stability, and could be an effective means for addition in cholesterol-reduced milk.

Key Words: Chitoooligosaccharide, Microencapsulation, Milk

T295 Functional properties of cholesterol-removed whipping cream treated by beta-cyclodextrin. S. Y. Shim, J. Ahn, and H. S. Kwak*, *Sejong University, Seoul, Korea.*

The present study was carried out to examine the changes in functional properties of cholesterol-removed whipping cream by beta-CD treatment. The cholesterol removal rate reached over 90% in cream before whipping with in all conditions (different stirring time and speed) applied. The apparent viscosity of beta-CD treated cream after whipping increased with increased stirring time and speed. Comparatively, the overrun percentage reached to 150%, and foam instability was measured as 2.5 mL deformed cream with lower stirring time (10 min) and speed (400 rpm). The TBA value of cholesterol-removed whipping cream increased from 0.08 to 0.14 stored at 4°C during 4 wk, however, no difference was found compared to that of control. Above results indicated that beta-CD treatment process for cholesterol removal did not show a profound adverse effect on functional properties of cream after whipping.

Key Words: Cholesterol Removal, Beta-Cyclodextrin, Whipping Cream

T296 Development of functional properties of water buffalo milk yogurt beverage. J. R. Huck, F. L. Lee, and M. Guo*, *University of Vermont, Burlington.*

A prototype yogurt beverage was developed using regional water buffalo milk, probiotic cultures and inulin. Water buffalo milk is considered to be more nutritious because it contains higher levels of calcium, fat, protein and antioxidants than cows milk. Probiotic bacteria such as *L. acidophilus*, *L. casei* and *Bifidobacteria* have shown to have beneficial effects to human intestinal health and are commonly added to commercial yogurt products. Inulin and oligofructose have been documented as prebiotics to provide fermentative stimulation to probiotic cultures and direct health benefits as non-digestible dietary fiber. Three trials of prototype yogurt beverages were prepared by adding whey protein concentrate and a probiotic yogurt culture mixture to pasteurized, homogenized water buffalo milk and incubating for 5.5 h. The cooled yogurt bases were then blended with a stabilizer mixture of water, sucrose, inulin, and pectin. A flavor and an acidulant were added prior to second homogenization process and bottling. Sensory evaluation by semi-trained panelists revealed acceptable textural and taste attributes of the yogurt beverage after 24 h in refrigerated storage of 3°C. Mean chemical composition of the product consisted of 11.2% carbohydrates, 2.7% fat, 1.8% protein, 0.3% ash and pH 3.65. Visual inspection and digital photographs showed the beverage remained stable up to twelve weeks. Survivability enumeration of probiotic cultures showed only levels of *L. casei* and *Bifidobacteria* to be above 10⁶ CFU/g at week 5. Therefore, a post-fermentation fortification of *L. acidophilus* to the yogurt beverage is recommended in order to maintain functional probiotic levels above 10⁶ CFU/g during refrigerated storage. In conclusion, symbiotic water buffalo yogurt beverage can be developed with probiotic cultures and functional prebiotic ingredients.

Key Words: Water Buffalo Milk, Symbiotic, Yogurt Beverage

T297 Effect of cheddaring temperature on moisture retention, rheological properties and proteolysis in model cheese systems. P. J. Watkinson, C. J. Coker, C. C. Dodds, S. Hewson, B. Kuhn-Sherlock, N. J. White, and L. K. Creamer*, *Fonterra Research Centre, Fonterra Co-operative Group Limited, Palmerston North, New Zealand.*

Removal of water from the rennet coagulum is important in cheese manufacture. Cheddaring is one of the ways that can be used to control the moisture content of a cheese. A series of model cheeses were prepared using a range of cheddaring temperatures to give cheeses with different moisture contents in order to determine the effect of cheese moisture on the development of certain rheological properties. Milk with a protein:fat ratio of 1.4:1 was acidified with acetic acid to a pH of about 6.1 and then coagulated with rennet (3.0 mL/100L). Each coagulum was cut and cooked (40°C), drained and then mixed with a measured quantity of glucono- δ -lactone (GDL). It was then cheddared in jacketed vats controlled between 10 and 60°C. The curd was then salted, hooped, pressed, wrapped, and stored at 5°C. The cheeses were sampled after storage from 2 to 184 days and then the rheological and compositional properties and intact casein were measured. Moisture contents of the cheeses were between 40 and 48% (average value over the storage time). The Hencky fracture strain (resistance to crumbling) increased with the moisture content of the cheeses and the effect was greater in the more mature cheeses. The adhesion area (adhesiveness) was similar but the modulus of deformability (stiffness) diminished with increasing moisture content and cheese maturity had a small and variable effect. The content of intact α_{s1} -casein decreased with increased moisture content, except for the two-day samples, which were assumed to contain 100% intact protein. The pHs of all cheeses were between 5.76 and 5.80. A second study used a set of cheeses with moisture contents between 34 and 39% (pHs between 5.51 and 5.54) and showed similar but slightly more complex trends. There was an apparent correlation between moisture content and the extent of proteolysis and some of the rheological properties. The relationship between moisture content and proteolysis may be indirectly responsible for the changes in rheological properties being correlated with moisture content.

Key Words: Model Cheese, Cheddaring Temperature, Rheological Parameters

T298 Effects of fat content on physico-chemical and sensory properties of buffalo milk dahi (yogurt). N. Pandya*¹, S. Kanawjia¹, and R. Dave², ¹*Dairy Technology Department, National Dairy Research Institute, Karnal, India*, ²*Dairy Science Department, South Dakota State University, Brookings.*

The use of fermented milks dates back to many centuries and dahi is one such fermented milk product occupying an important place in Indian diet satisfying the palate and nutritional requirements of human beings. Commercial production of dahi is still in infancy stage in India and very few studies are available on the effects of ingredients on physico-chemical and sensory properties of dahi made from buffalo milk. This study was aimed to optimize the fat content in buffalo milk dahi. Fat levels studied were 1.5, 3.0 and 4.5% with solids not fat maintained at 9.5% level in all the samples. It was observed that during the first 12 h of incubation, the rate of drop in pH and the rate of increase in acidity were faster in milk with 1.5 and 3.0 % fat as compared to the milk with 4.5% fat. However, after 12 h of incubation, the rate of change in pH and acidity became almost similar at all fat levels studied. Also, the optimum set time increased up to 2.5 h with the increase in fat content from 1.5 to 4.5%. Rheology and sensory properties improved significantly ($P < 0.05$) with increasing fat content. With the increase in fat content from 1.5 to 4.5%, the average increase in viscosity was 22.5%, wheying off reduced by 31% and curd tension improved by 10%. Also, with increase in fat content from 1.5 to 4.5 % in dahi, the flavor scores improved from 40.7 to 48.3 out of 50, the body & texture scores improved from 35 to 38.8 out of 40.0, and there was no significant difference ($P < 0.05$) in appearance scores. Keeping in view the overall sensory characteristics and different rheological properties of dahi, fat level of 4.5% was suggested for the commercial production of dahi.

Key Words: Buffalo Milk, Fat, Dahi

T299 Understanding the role of proteolysis in reduced calcium Mozzarella cheese. P. R. Thakur* and R. I. Dave, *Dairy Science Department, South Dakota State University, Brookings.*

Calcium content plays an important role in the functional properties of cheese. Recent study showed that reduced calcium Mozzarella cheeses not only had improved softening, melting and flow characteristics, but also had higher proteolysis. The objectives of this study were to characterize the proteolysis in Mozzarella cheese at various storage periods, correlate the melt properties to the proteolysis and also study the effects of coagulants (chymosin and Sure Curd[®]) on the proteolysis of reduced calcium Mozzarella cheese. Mozzarella cheeses were made by direct acidification using Glucono- δ -Lactone. The milk was pre-acidified using citric acid and acetic acid to a pH of 5.9 to lower the level of calcium. No alteration in the calcium content of control cheeses was made. The composition of cheeses were kept as uniform as possible by adjusting the processing conditions. The samples were analyzed on day 1, 7, 15 and 30 for various study parameters. Proteolysis as measured by water-soluble nitrogen (WSN), TCA - soluble nitrogen and PTA - soluble nitrogen was higher in reduced calcium cheeses. The water-soluble nitrogen for reduced calcium cheeses was almost double than the control cheeses on day 1. WSN changed only a little throughout the storage period in control cheeses, but it increased in reduced calcium cheeses during storage. TCA -soluble nitrogen increased over the storage period in reduced calcium cheese while the increase in PTA - soluble nitrogen was very little. Also, the proteolysis was higher in cheeses manufactured using sure curd in comparison to the cheeses manufactured using Chymosin. The melt area for reduced calcium cheeses was 2.1 times higher than the control cheeses. Control cheeses had higher expressible serum than the reduced calcium cheese throughout the storage, which shows higher water-holding capacity of reduced calcium cheeses. The fluorescence microscopic images showed better distribution of fat within the protein matrix of reduced calcium cheeses.

Key Words: Reduced Calcium Mozzarella Cheese, Proteolysis, Coagulant

T300 Milk from cows fed potato by-products indistinguishable from whole milk. M. L. Nelson*, M. J. Costello, M. F. Morrison, and S. Clark, *Washington State University, Pullman.*

Four multiparous Holstein cows (761 ± 18 kg body weight; 119 ± 2 d in milk) were randomly assigned to a 4x4 Latin Square to determine effects of type of potato by-product in a TMR on milk production, composition, and quality. Periods were 28d (21d for adaptation, 7d for milk

collection). Cows were fed a TMR with none or 15% replacement of the grain portion with a potato by-product (filter cake, potato peels, or screen solids). Daily feed intake and milk production were quantified. Weekly milk subsamples were analyzed for milk composition. Total milk, from each cow, was collected at both milkings on d 22, pasteurized, homogenized, and cooled. Milk was evaluated by a 9 member trained sensory panel and a 40 member consumer panel in each period. Cows fed potato byproduct containing diets consumed less ($P < 0.05$) DMI (26.6 vs. 20.8 ± 0.65 kg) with no effects ($P > 0.05$) on milk production (41.6 ± 0.54 kg/d), milk fat (3.5 ± 0.10 %), or weight change (0.3 ± 0.1 kg/d). No differences ($P > 0.05$) due to diet were detected in 17 milk attributes by the trained sensory panel. Consumer panels paired milk samples from potato peel-fed cows and screen solid-fed cows more than by chance (63.7 ± 14.2 %, 59.7 ± 11.8 %), which was not due to milk composition or sensory attributes identified by the trained sensory panel. Potato byproducts, by replacing grain in a TMR, resulted in reduced DMI without affecting milk production, composition or sensory attributes.

Key Words: Milk, Potato By-Product, Sensory Evaluation

T301 Microstructure of pasteurized Process cheese manufactured from vacuum condensed and ultrafiltered milk. V. V. Mistry*, A. N. Hassan, and M. R. Acharya, *MN-SD Dairy Foods Research Center, Dairy Science Department, South Dakota State University, Brookings.*

Milk concentrated by ultrafiltration (UF) or vacuum condensing (CM) to two levels of protein: 4.5% (UF1 and CM1) and 6.0% (UF2 and CM2) or Control (C) with 3.2% protein was used for manufacturing Cheddar cheese (Acharya et al. 2001. *J. Dairy Sci.* 84 (Suppl.1):306). Pasteurized Process cheeses were manufactured using a 1:1 blend of 18-week and 30-week Cheddar cheese (Acharya et al. 2002. *J. Dairy Sci.* 85: (Suppl. 1):357). The moisture content of the Process cheeses ranged from 39.3 to 40.2%. Fat content was the highest in C (35.0%) and the lowest in UF2 (31.6%). The microstructure of cheeses was evaluated using cryo-scanning electron microscopy and fluorescence microscopy. Process cheeses with the highest meltability (Control) demonstrated a structure in which fat globules of varying size were uniformly distributed in a porous protein matrix. The porosity of the protein matrix decreased with decreasing meltability (UF2, CM1 and CM2). Cheeses with minimal porosity were the hardest; 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). Similarly, viscosity of molten cheese at 80°C correlated to this structural feature and was higher in 6.0% protein treatments (1043 cp-UF2 and 1208 cp-CM2) than in 4.5% protein treatments (855 cp-UF1 and 867 cp-CM1) and in C (557 cp). It was also interesting to note that the fat globules in control cheeses were surrounded by greater void space relative to the other cheeses. The application of concentrated milks for Cheddar cheese-making influences Process cheese functionality and structure.

Key Words: Process Cheese, Concentrated Milk, Microstructure

T302 Flavor and stability of pasteurized milk with elevated levels of conjugated linoleic acid and vaccenic acid. J. M. Lynch¹, A. L. Lock², D. A. Dwyer², R. Norbaksh³, D. M. Barbano*¹, and D. E. Bauman², ¹*Northeast Dairy Foods Research Center, Department of Food Science, Cornell University, Ithaca, NY*, ²*Department of Animal Science, Cornell University, Ithaca, NY*, ³*Institute of Standards and Industrial Research, Mashhad, Iran.*

The objectives in this study were to determine if flavor differences between 2% fat pasteurized milks with and without elevated vaccenic acid (VA) and cis-9, trans-11 CLA levels could be detected over the commercial shelf life of the product and to determine if milk with elevated VA and cis-9, trans-11 CLA levels was more susceptible to light-induced oxidative flavor defects. Cows were fed either a control diet ("control" diet) or the same ration supplemented with 2% soybean oil and 1% fish oil ("CLA" diet). Control and CLA raw milks were collected and separated into cream and skim. The skim and cream from each treatment were combined to achieve 2% fat milk. The milks were pasteurized, homogenized and stored in commercial clear plastic milk containers at 4°C. Oxidation was induced by exposing half of the containers to fluorescent light. Testing was conducted at 1, 7 and 14 days post-pasteurization. Average cis-9, trans-11 CLA content of the control and CLA milks was 0.52 and 4.74 g/100g fatty acids, respectively (812% increase). Average

VA content of the control and CLA milks was 1.43 and 12.06 g/100 g fatty acids, respectively (743% increase). There was no effect of light exposure on fatty acid composition either initially or over the 14-day storage period. Although VA, cis-9, trans-11 CLA and degree of unsaturation were significantly elevated in the CLA milk, untrained panelists were unable to detect flavor differences either initially or over time in 15 out of 16 triangle test evaluations. Similarly, sensory results indicated no difference in susceptibility to the development of oxidized off flavor between the control and CLA milks, even when oxidation was induced by light exposure.

Key Words: CLA, Fluid Milk, Flavor

T303 Evaluation of long term frozen-storage effect on chemical changes in soft and semi-hard goat milk cheeses. J. H. Lee*, Y. W. Park, and B. L. Gadiyaram, *Fort Valley State University, Fort Valley, GA.*

Freezing cheese is not common practice in dairy industries due to the high production costs and possible adverse effects on physico-chemical, rheological, and sensory qualities of the frozen products. However, frozen-storage of cheese as a food technological approach may be essential for extending marketability of caprine milk products. Three lots of plain soft (PS) goat cheeses were purchased, and 3 lots of Monterey Jack (MJ) goat cheeses were manufactured at the University dairy plant to study changes in chemical parameters such as pH, acid degree value (ADV), water soluble nitrogen (WSN) profiles during 6 months of extended frozen and refrigerated storage. Each cheese variety was subdivided into 4 equal portions, and stored at 4°C for 4 weeks (0, 14, 28 days) as the unfrozen control, and the other three subsamples were frozen (-20°C) and stored for 0, 3 and 6 months, then immediately thawed the next day at 4°C, followed by aging at 4°C for 4 wks. For PS cheese, ADVs were increased ($P < 0.05$) with frozen storage time (0.5 to 0.7) and subsequent refrigeration time (0.5 to 0.7). However, the levels of WSN were only influenced by subsequent refrigeration time (9.2 to 10.5). The pH (4.0 to 4.1) was not affected by freezing and subsequent refrigeration. Both proteolysis and lipolysis properties of PS cheese were affected by freezing and subsequent refrigeration. For MJ cheese, neither pH nor ADV was affected by freezing/subsequent refrigeration in MJ sample. The pH was ranged from 5.8 to 6.1 during the experimental period; the ADV was varied from 1.2 to 1.5. WSN contents of MJ were significantly decreased against frozen storage time from 0 to 6 mo (16.6 to 15.3), whereas subsequent refrigeration did not influence to the WSN. Increasing frozen storage time may influence the protein degradation in MJ. Frozen storage time and subsequent refrigeration impacted on flavor compounds and protein degradation, but not on the chemical properties related to lipolysis (ADV) and pH.

Key Words: Goat Cheese, Long Term Frozen-Storage, Chemical Changes

T304 Feasibility study of forming a California cheese aging cooperative. B. A. Reed*, *University of California Cooperative Extension, Orland.*

California artisan cheesemakers were contacted to assess their interest in the development of a cheese aging cooperative and collect information on the scope of services desired. Twelve cheesemakers agreed to

participate in the survey. Average cheese production was 41681 kg/yr with a range of 5443 to 145150kg/yr. Facilities made an average of 6 cheese varieties with a range of 1 to 12. The collective volume of cheese aged <60 d, 2-5 mo, 6-12 mo, 13-23 mo and >2yr was 179750, 141657, 155002, 42547 and 2132 kg respectively. Cheese shipped from the plant cut and wrapped versus whole wheels was 34.2% and 65.8% respectively. Cheese makers reported primary barriers to expansion as lack of storage or processing space (4), or the cost of space (1), cash flow (3), milk supply (1), expertise in aging (1), and distribution (1). Secondary barriers identified were, processing space (2), storage space (1), labor (2) and housing costs for labor (1), freight costs (1), (unspecified) problems with distribution (2), lack of cross docking and drop points to improve distribution (1), risk and cost of expansion (1), and cash flow (1). For the producers interested in using a facility, features/services offered by a facility ranked in importance on a 10 point scale from highest to lowest were, retain ownership and identity (8.8), added storage space (8.5), assistance with aging (7.2), cash advance for cheese (6.3), marketing and distribution assistance (6.2), better risk protection (5.0) and unique marketing identity (4.7). Financial analyses developed from the survey information showed an average cost for aging cheeses in a cooperative at \$1.37, \$0.95 and \$0.95/kg for years 1, 2 and 3 respectively with 5 initial member/owners and a rolling monthly inventory of 11340 kg. The charge needs to drop to \$0.44/kg for the aging cost not to exceed the price differential for an aged cheese.

Key Words: Cheese Aging, Costs, Cooperative

T305 Release of antioxidants from biodegradable films into dry milk products and food simulating liquids. M. van Aardt¹, S. E. Duncan*¹, J. E. Marcy¹, T. E. Long², S. F. O'Keefe¹, and S. R. Sims³, ¹*Food Science and Technology, Virginia Tech, Blacksburg,* ²*Chemistry, Virginia Tech, Blacksburg,* ³*Eastman Chemical Company, Kingsport, TN.*

Poly(lactide-co-glycolide) (50:50) films loaded with antioxidants (i) 2% α -tocopherol, and (ii) a combination of 1% butylated hydroxytoluene (BHT) and 1% butylated hydroxyanisole (BHA), were used in an antioxidant release study in water and Miglyol 812[®] at 4°C and 25°C, as well as a study on the effect of these films on dry whole milk and dry buttermilk stability. BHT was released through the hydrolytic degradation of the polymer when stored in water at room temperature for eight weeks. As expected, polymer degradation did not take place when antioxidant-loaded films were stored in whole milk powder (3.01% moisture) and buttermilk powder (4.60% moisture). However, α -tocopherol, BHA, and BHT were released through diffusion from 0 mg/kg to 21.9, 60.0, 192.0 mg/kg milkfat, respectively, in whole milk powder after four weeks of storage at 25°C. Buttermilk powder did not show increasing antioxidant content, which might be due to a much lower fat content (2.35%), as compared to whole milk powder (24.48%). Milkfat stability was measured by determining hexanal, pentanal, and heptanal content. Although limited reductions were observed in these volatiles in control- and antioxidant-treated powders, pentanal content was significantly decreased for the first three weeks of storage when buttermilk powders were packaged in contact with BHA/BHT-loaded PLGA films.

Key Words: Antioxidants, Lipid Oxidation, Milk Powder

ABSTRACTS
Tuesday, July 27, 2004

SYMPOSIA AND ORAL SESSIONS

* Author Presenting Paper

Bioethics: Symposium-Ethics and the Cost of Food: What is the Impact of Lessening Food Prices on Citizens, Producers, Animals and the Environment?

347 Cheap food and its impact upon health, safety and security of supply. J. Hodges*, *European Association of Animal Production, Mittersill, Austria.*

During the 2nd half of the 20th century, the pursuit of cheap food has been the prime strategy of animal and agricultural scientists in Western society. Intellectual and organizational resources are shaped to serve this objective. These include disciplinary research in the biosciences, management systems, mechanisms to maximize scale, recycling of waste and by-products, increased capitalization, reduced labor, and the relocation of production sites nationally and internationally. Alternatives are often dismissed as inefficient and unrealistic in the age of Homo economicus. Some non-monetary values have recently appeared in the equation: human health, food safety, gustatory food quality, animal welfare and quality of rural life challenging the monolithic dominance of the cheap food movement. But mainstream Western agriculture, fuelled by the powerful engine of science allied to business, still dominates by seeking ever cheaper food. I argue that this mainstream ideology will not change while the unseen external costs remain hidden and apparently painless. Nevertheless informed people know that the mainstream system is unsustainable in terms of biological resources, the environment, the quality of human life and in the civilized values for treatment of other people and of animals. In this paper, some options are explored by which these hidden costs might be factored into the visible costs of the food chain. Globalization of food production is built upon the cheap food Western model of intensification, capitalization and specialization. But the history and current experience of food in the West finds national governments as major players in regulating health, safety and providing economic support. The prospect of major global food supplies responding solely to market forces holds threats of instability and unsustainability with food shortages, disruption of family farms and rural societies in the developing countries plus health and safety issues outside regulatory control. The paper concludes that food deserves more

care nationally and internationally than the fate of being driven into the 21st century solely by the ideology of low cost.

Key Words: Cost, Safety, Sustainability

348 Considerations of the relationship between food prices and animal welfare. M. C. Appleby*, *The Humane Society of the United States, Washington, DC.*

The proportion of income spent on food has been in steady decline. Most people could readily pay more for food. Indeed, most consumers already pay more than necessary, by buying specialist products or convenience foods. But there are costs associated with cheap food produced from animals that reach well beyond the dollars paid by citizens at the checkout register of a supermarket or fast food restaurant. A morally significant effect of pressure for cheap food production has been modifications to production methods that may have impacts on animal welfare; for example by decreased space allowances. Cheaper food for humans sometimes involves greater pain and suffering for food animals. Yet improvements, possibly even major improvements, in welfare could be achieved with only small increases in price to the consumer. The obstacle to change is in part economic inertia - producers resist change because buyers expect low prices. Deployment of public subsidies and gradual change could avoid these short-term effects, although protection is needed against imports from countries with even lower welfare consideration and environmental standards. From the viewpoint of doing what is appropriate for animal welfare and the environment, free market competition should no longer be the sole determinant of food prices. Animal scientists can serve the long-term interests of animal agriculture by combining efforts to do the right thing for welfare of animals with more traditional goals.

Key Words: Animal Welfare, Economic Competition, Food Prices

349 Interrelationships of animal agriculture, the environment and rural communities. M. G. Hogberg*¹, F. L. Kirschenmann², S. L. Fales³, M. S. Honeyman¹, and J. A. Miranowski⁴. ¹Department of Animal Science, Iowa State University, Ames, ²Leopold Center for Sustainable Agriculture, Iowa State University, Ames, ³Department of Agronomy, Iowa State University, Ames, ⁴Department of Economics, Iowa State University, Ames.

Animal agriculture has an obvious, close interrelationship with both the natural environment and also with human systems such as the rural community. Accordingly, changes in animal agriculture can have broad ranging consequences to other areas. Tremendous change in animal agriculture has occurred during the past 50 years. In general this has involved an increase in size of production units, greater reliance on technology, a corresponding decrease in labor, increased animal confinement, and a general trend toward monoculture or specialized production systems. At least in part these changes were brought about by animal science research in nutrition, breeding, reproduction, growth, etc. A long-term goal of animal scientists has been to increase biological efficiency of production, and the success in reaching this goal could be said to be remarkable with the time to market, growth rates, milk and egg production, etc. per animal increasing as much as 2 to 3 times in the 50 years. The increase in the efficiency has brought about a parallel decline in food prices. But while animal science in one sense has been very successful, new questions or issues have emerged. The scale of animal systems today sometimes concentrates large numbers of animals into areas smaller than can easily handle the animal waste. Stream and ground water pollution is increasingly a concern in some regions. Odor is a nuisance problem that increasingly places urban growth in conflict with confinement animal systems. Possibly one of the biggest issues can be stated in terms of sustainability; i.e., are all current food animal production systems ones that can continue as they currently exist. Additionally, the decline in numbers of producers has impacted the sociology of rural communities and in some cases brought about the closure of small towns. Animal scientists typically contend that they serve the interests of producers and strive to promote practices that are environmentally sound. Bringing about a discussion among animal scientists

Lactation Biology: Symposia: Molecular Mechanisms Governing Mammary Development

351 Emerging genomic technologies for studying mammary development and mammary cancer. D. Porter*^{1,2} and K. Polyak^{1,2}. ¹Dana-Farber Cancer Institute, Boston, MA, ²Harvard Medical School, Boston, MA.

The breast cancer genetics lab at the Dana-Farber Cancer Institute is currently using genomic approaches to understand the biology of the mammary gland and breast tumorigenesis. This work has involved global gene expression profiling of normal and cancerous mammary tissue to identify diagnostic, prognostic, and therapeutic targets in breast cancer as well as follow-up experiments on candidate genes to more fully characterize gene expression and physiological function. SAGE (Serial Analysis of Gene Expression) is an expression profiling method that allows for global, unbiased, and quantitative characterization of transcriptomes. The expression of thousands of genes can be analyzed simultaneously without prior knowledge of their sequence, thus leading to the discovery of novel transcripts. Importantly, this makes SAGE a particularly useful tool for use in species with incompletely characterized genomes like the dairy cow. We have used SAGE to characterize normal and malignant gene expression patterns in the human breast, and we have identified genes involved in mammary epithelial cell differentiation, proliferation, and survival that may be involved in the initiation and/or progression of breast cancer in humans. In addition, we have combined immuno-magnetic cell sorting and SAGE to describe the comprehensive gene expression profiles of individual cell types composing breast tissue thus providing a molecular portrait of potential autocrine and/or paracrine interactions among cell types in the mammary gland. The application of these technologies in the dairy cow will lead to the discovery of important new genes and has the potential to yield important insights into the molecular basis of developmental processes in the mammary gland.

Key Words: Genomics, Mammary, SAGE

as to whether these goals are always met, or could be better met, is considered to be a worthwhile endeavor.

Key Words: Animal Agriculture, Food Prices, Environment

350 Ethics and low-priced meat, milk and eggs: Too much of a good thing? R. J. Burkhardt*, University of Florida, Gainesville.

There can be little doubt that decreases in food prices are generally thought to be in consumers best interests. If we wish to base judgments about the ethical soundness of practices designed to reduce food prices on a human welfare-optimization, or utilitarian, ethical norm, then those practices are seemingly right. One assumption that has to be made in this regard is that prices are high enough to keep producers in business. Assuming that is true, one question that arises is whether lower prices are ethically sound for all foodstuffs. It could be argued, for example, that low wheat or corn or rice or vegetable prices are ethically sound because these are food staples, and in some form consumed by people from every socioeconomic and demographic category, both domestically and around the world. When we consider food from animals, the argument is not so easily made. It could be, for example, that lower meat, milk and egg prices means that more ostensibly "free" resources such as water are being consumed by the respective industry, and additional animal wastes are being introduced into the environment. These "hidden costs" are not to be ignored in a long-run utilitarian assessment of the ethics of lower animal-based food prices. However, the more significant ethical concern is whether lower prices encourage more consumption, and given connections between animal fats and risks to human health, should additional meat, milk and egg consumption be encouraged? This is made all the more important when we think about what economists call "substitution effects": will lower prices for animal products encourage the substitution of meat, milk and eggs for other food products, also essential to human well-being?

Key Words: Applied Ethics, Animal Agriculture, Food Costs

352 Hormonal regulation of mammary growth, morphogenesis, and breast cancer. R. C. Hovey* and J. F. Trott, University of Vermont, Burlington.

Mammary development in all species is regulated by a complex interplay of hormones that reflects the reproductive state of a female, ultimately in preparation for lactation. These changes translate to phases of ductal development with associated branching and lobulogenesis, alveologenesis, secretory activation, and subsequent involution. Separately, breast cancer can arise as a function of dysregulated growth by normal mammary epithelial cells. Notably, these changes occur in a tissue microenvironment that can act as a site of local mediation for hormonal cues. Our lab has addressed questions concerning the hormonal regulation of normal mammary gland development and the local changes that mediate this input during processes associated with cell proliferation, morphogenesis and breast cancer. In particular, we have addressed the combinatorial regulation that occurs with alterations in the pituitary-ovarian axis in several species. Our data demonstrates that hormonal cross-talk and its local mediation by autocrine and paracrine factors is a key determinant of specific proliferative and morphogenic events. It also serves to regulate changes in supporting tissues such as the vascular endothelium and surrounding stromal. Currently we are delineating some of the transcriptional mechanisms underlying these changes with the objective of defining key pathways downstream of hormonal regulation during mammary development and breast cancer progression.

Key Words: Mammary Gland, Hormones, Gene Expression

353 Developmental and nutritional regulation of steroid receptor mRNA expression and epithelial cell proliferation in the prepubertal bovine mammary gland. M. J. Meyer^{*1}, A. V. Capuco², A. Hummel², E. E. Connor², Y. R. Boisclair¹, and M. E. Van Amburgh¹, ¹Cornell University, Ithaca, NY, ²USDA-ARS, Beltsville, MD.

Estrogen and its alpha receptor (ER α) are thought to mediate the ovaries influence on prepubertal mammary epithelial cell proliferation (MEP) in the bovine. The ER beta isoform (ER β) and the estrogen-related receptor α 1 (ERR α 1) may also play a role in estrogen mediated MEP. To better understand these relationships, the developmental and nutritional regulation of ER α , ER β , and ERR α 1 mRNA abundance was determined in prepubertal bovine mammary parenchyma (PAR) and fat pad (FP) by real-time RT-PCR. Holstein heifers (n = 72) were fed to grow at 950 (E) and 650 (R) g/d from birth to slaughter at 50kg increments between 100 to 350kg BW. MEP was assessed by BrdU labeling and estrogen responsiveness by quantity of progesterone receptor (PR) transcript. ER β mRNA abundance was exceedingly low and appeared unregulated. E-heifers tended to have greater abundance of ER α , ERR α 1, and PR mRNA in PAR (P < 0.10) and greater ER α mRNA abundance in FP (P < 0.05) than R-heifers. Furthermore, expression of ER α was localized to FP fibroblasts by immunohistochemistry. ER α , ERR α 1, and PR mRNA abundance decreased linearly (P < 0.08) with increasing BW in PAR but not in FP. At 100kg, E- had greater MEP than R-heifers (P < 0.05). Beyond 100kg, MEP decreased rapidly with increasing BW and was similar between treatments. Among all heifers, MEP and PAR PR mRNA were positively correlated with PAR ER α mRNA abundance (r = 0.42 and 0.80, respectively, P < 0.05). Data suggest that expression of ER α , ERR α 1 and PR are developmentally regulated within PAR but not FP, implying tissue specific regulation of

these genes. Energy intake appears to increase PAR expression of these transcripts, but has no effect on MEP.

Key Words: Heifer, Mammary Development, Estrogen Receptor

354 Estrogen and progesterone response networks in the mouse mammary gland. D. J. Jerry^{*}, S. Lu, A. L. Roberts, and K. A. Dunphy, *Department of Veterinary & Animal Sciences, University of Massachusetts, Amherst.*

A majority of mammary gland development occurs post-natally and is controlled by many environmental factors including nutrition, exposure to environmental compounds and endogenous hormone status. The complement of signals not only influence milk yield in subsequent lactations in livestock, but have a striking effect on subsequent risk of breast cancer in humans. The p53 tumor suppressor protein senses cellular stresses and arbitrates the decision of whether a cell should undergo arrest, senescence or apoptosis. Given the gravity of these decisions, it would be expected that levels of p53 activity should be constrained within physiological limits so that cells are not removed inappropriately resulting in loss of secretory epithelium. Nor should levels of p53 be impaired excessively as cells bearing genetic alterations would be allowed to survive raising the risk of cancer. The physiologic role of p53 in the mammary gland is most evident in the fact that impaired p53 function results in delayed involution in rodents. Similarly, activity of p53 is enhanced by estrogen and progesterone, presumably to enforce heightened surveillance of cells undergoing replication to ensure that genomic integrity is maintained. Therefore, we undertook a series of experiments to map the transcriptional responses initiated by these hormones that are crucial to both growth and development of the mammary epithelium as well as suppression of mammary tumorigenesis.

Key Words: Mammary, Estrogen, Progesterone

Ruminant Nutrition: Science of Ruminant Nitrogen Metabolism and Its Application to Feeding Cows

355 What is the true supply of amino acids? H. Lapierre^{*1}, D. Pacheco¹, R. Berthiaume¹, D. R. Ouellet¹, C. G. Schwab², G. Holtrop³, and G. E. Lobley³, ¹Lennoxville Research Centre, AAFC, Lennoxville, QC, Canada, ²University of New Hampshire, Durham, ³BIOSS, Rowett Research Institute, Aberdeen, UK.

Improving the prediction of milk protein yield relies on knowledge of both protein supply and requirement. Definition of protein/amino acid (AA) supply in ruminants is a challenging task, due to feedstuff variety and variability, and to the remodeling of nutrient intake by the rumen microflora. So, how and where should we measure the real supply of AA in the dairy cow? This review will follow the downstream flow of AA from duodenum to peripheral tissue delivery, with a glance at the efficiency of transfer into milk protein. Duodenal AA flow comprises rumen undegradable feed, microbial protein, and endogenous secretions. Most attention has been directed towards definition of the first two contributions, but the latter fraction can represent up to 20% of flow and more information is needed on what factors affect its magnitude and overall impact. Once digested, AA are absorbed into the portal vein. The ratio of portal absorption to small intestinal apparent digestion varies among AA, from 0.50 (threonine) to 0.85 (histidine), due to pre-duodenal endogenous secretions, non-reabsorption of intestinal endogenous secretions and gut oxidation of AA. Few data are available on these phenomena in dairy cows, but the evidence indicates that they alter the profile of AA available for anabolic purposes. Recent comparisons of estimated duodenal flux and measured portal flux have prompted a revisit of the NRC (2001) approach to estimate AA flows at the duodenum. New equations are proposed that yield predictions that better fit the current knowledge of AA metabolism across the gut. Absorbed AA flow first to the liver, where substantial and differential net removal occurs, varying from zero for the branched-chain AA to 0.50 of portal absorption for phenylalanine. This process alters the pattern of net supply to the mammary gland. Overall, intermediary metabolism of AA between the duodenum and the mammary gland biologically explains the decreased efficiency of the transfer of absorbed AA into milk protein as maximal yield is approached. Therefore, variable, rather than fixed factors for transfer efficiencies, must be incorporated into future predictive models.

Key Words: Dairy Cows, Amino Acids, Splanchnic

356 Impacts of the source and amount of crude protein on the intestinal supply of nitrogen fractions and performance of lactating dairy cows. J. H. Clark^{*} and I. R. Ipharraguerre, *Department of Animal Sciences, University of Illinois, Urbana.*

At the onset of a new century, increasing cow productivity and concerns about the environment and safety of food for human and animal consumption in combination with shrinking profits of dairy producers have renewed the challenge first faced by scientists almost 100 years ago. That is, it is fundamental to establish the minimum amount of protein required by today's high-producing dairy cows for achieving optimal milk production. In addition, it is important to identify protein sources that will accomplish that goal with maximum efficiency from a nutritional and economical standpoint. The main objective of this paper is to review and summarize the impacts of the source and amount of dietary crude protein on the supply of nitrogen fractions to the small intestine and the consequential performance of lactating dairy cows. An attempt will be made to quantitatively integrate literature data into a summary that will contribute to our understanding of the flow of protein fractions from the rumen of dairy cows and their effects on dietary protein requirements. Specifically, this approach will focus on providing estimates of the magnitude and significance of documented alterations in the supply of nitrogen fractions to the lower gastrointestinal tract and performance of dairy cows in response to manipulations of the amount and source of dietary crude protein. The ultimate goal of this review is to provide information that may be helpful for identifying areas where further research is required, for comparing new research outcomes, or for evaluating parameterization of computer-based models currently used for predicting the response of lactating cows to the feeding of different diets.

Key Words: Crude Protein, Dairy Cows, Review

357 Nitrogen Supply to the Lower Gut and Its Relationship to Animal Performance in Beef Cattle. T. J. Klopfenstein^{*} and G. E. Erickson, *University of Nebraska, Lincoln.*

Beef cattle require amino acids for maintenance and growth. The amino acids are supplied to the lower gut as microbial protein and undegraded

intake protein (UIP). The balance of amino acids depends upon the proportion of UIP and the amino acid spectrum of the UIP. Therefore, it is absolutely essential to measure or predict the relative amounts of MP (metabolizable protein) from microbes and UIP in any given feeding scenario. Both the production potential of the beef animal and microbial protein synthesis are driven by energy. It is impossible to predict MP supplied to the lower gut and MP needs of the animal without having accurate estimates of energy needs, energy supplies and ruminal energy availability. While there are many variations on beef production systems, most are based on high grain (finishing) diets or high forage diets. Forage contains little UIP and that UIP appears to be poorly digested (<50%). Without supplements, essentially all of the MP in forage feeding situations is supplied by microbes. Site of carbohydrate digestion (NDF) is relatively predictable and methodology for measuring forage protein degradation is relatively precise (NDF-N). Degradable intake protein (DIP) may be deficient in some situations. Microbial protein synthesis efficiency decreases as diet TDN decreases from 60% down to 45 to 50%. Low microbial production and low forage UIP create MP deficiencies in many forage feeding situations. On high grain diets, energy supply is high but microbial efficiency is limited by low ruminal pH. Site of carbohydrate digestion (starch) varies with grain type and processing. Estimation of ruminal degradation of grain (starch and protein) is not precise. DIP is usually required. Byproducts reduce starch, raise pH and add protein (maybe DIP or UIP depending on byproduct). Corn is high in UIP and the UIP is highly digested (>90%). Therefore feedlot cattle generally have adequate supplies of MP. It is difficult to produce an amino acid deficiency in feedlot cattle. Growing cattle can be deficient in specific amino acids depending upon the amino acid balance in the UIP.

Key Words: Beef Cattle, Metabolizable Protein, Amino Acids

Swine Species Symposium. Improving Sow Productivity: Recent Developments in Gilt and Lactation Management

359 Increasing weaning age improves pig performance and profitability in a multi-site production system. R. G. Main*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

Two trials were conducted to determine the effects of weaning age on growing pig biologic and economic performance in a multi-site production system. Trial 2 also evaluated the effects of modifying nursery feed budgets according to weaning age. In trial 1 (2,272 pigs), treatments included weaning litters at 12, 15, 18, or 21 d of age. In trial 2 (3,456 pigs), litters were weaned at 15, 16, 18, 19, 21, or 22 d of age and categorized into three treatments (15.5, 18.5, or 21.5 d of age). In trial 2, pigs in each age group were fed a nursery feed budget classified as more or less complex. Since feed budget did not affect ($P > 0.27$) performance, only weaning age effects are presented. Each trial was conducted as a randomized complete block design with four blocks of linked nursery and finishing sites (6 and 10 reps/block in trials 1 and 2, respectively). All wean age treatments were weaned from a 7,300-head sow farm on the same day into the same nursery. Each block remained intact as pigs moved from nursery to finishing site. Costs and revenue were measured for each pen. Increasing weaning age (12, 15, 18, or 21; and 15.5, 18.5, or 21.5 in trials 1 and 2, respectively) improved (linear, $P < 0.03$) wean-to-finish ADG (580, 616, 637, 687 ± 8 g/d; 676, 697, 722 ± 6 g/d), mortality rate (9.4, 7.9, 6.8, 3.6 ± 0.95 %; 3.9, 3.4, 2.5 ± 0.5 %), weight sold per pig weaned (94.1, 100.5, 104.4, 113.1 ± 1.3 kg, 107.6, 111.6, 116.2 ± 1.1 kg), income over costs (\$2.00, 5.11, 7.12, 11.19 ± 0.52 /pig; \$7.99, 10.04, 12.46 ± 0.46 /pig), and cost per hundred kg sold (\$86.19, 83.24, 81.49, 78.36 ± 0.46 ; \$80.80, 79.25, 77.50 ± 0.32). The improvements in growth and mortality largely occurred in the initial 42 d after weaning, with smaller growth improvements in finishing. These studies indicate that increasing weaning age up to 21.5 d predictably improves grow-finish throughput (1.80 ± 0.12 kg sold/pig/d of age) and profitability ($\$0.89 \pm 0.05$ /pig/d of age) within this multi-site production system.

Key Words: Weaning Age, Pigs, Economics

358 Mathematical models used to determine ruminant protein requirements and availabilities. R. A. Kohn*¹ and M. D. Hanigan², ¹*University of Maryland, College Park,* ²*Land O' Lakes/Farmland Feeds, LLC, St. Louis, MO.*

The objective of this presentation is to review the functional differences between mathematical models that are used to formulate diets for beef and dairy cattle with respect to protein and amino acid requirements. An ideal model for diet formulation would require minimal data input to accurately predict the amount and form of protein required by the animal and supplied by available feedstuffs. Where appropriate, there should be a means to incorporate feed analysis results into the model to improve predictions. All current models divide dietary crude protein into two parts: that required by ruminal microbes and that required at the small intestine as true feed protein that has not been digested by ruminal microbes. The most recent models have established specific requirements and availabilities of the first limiting amino acids (e.g. lys, met). The Cornell model (CNCPS) also formulates for required amino acid and peptide protein (as opposed to non-protein nitrogen) for rumen fermentation. The 2001 NRC can incorporate soluble protein information, and the CNCPS can use protein solubility in buffers and detergents as indicators of protein degradation. When several models (NRC, 1989; CNCPS, CPM Dairy) were compared for their ability to predict protein flows to the small intestine for typical diets and cows, there were no obvious advantages for any one model. However, the NRC, 1989 was best able to predict losses in milk production due to underfeeding of protein to dairy cows. The 2001 NRC increased both RDP and RUP requirements for dairy cows without affecting the supply. As a result, the total CP recommended in diets increased for the 2001 NRC compared to the 1989 version. However, the amount recommended in the 1989 NRC was adequate. The various models that currently are available differ substantially in their level of complexity and the number and type of feed analyses that can be used. But, there is little evidence that this increased complexity has improved the accuracy of model predictions for typical farm conditions.

Key Words: Protein Requirements, Mathematical Models

360 Behavior of sows during lactation. J. McGlone*, *Pork Industry Institute, Texas Tech University, Lubbock.*

Sow behavior is influenced by their genes and by their environment. During lactation, sows undergo significant changes in physiology that cause large behavioral changes. The objective of this review is to summarize the literature on sow behavior during lactation and the effects of management practices (such as weaning age and housing system) on sow behavior. Also, this review will summarize sow behaviors that lead to problems with the lactating sow or piglets. Sows undergo four major phases of behavior in the peri-lactation phase. First, prior to farrowing, sows undergo nest-building behavior that may involve building of an actual nest if sows are given building materials or expression of phantom nest-building behaviors in the absence of building materials. The second phase involves the establishment of the maternal-neonatal bond. This phase requires 12 to 24 h and is critical for piglet survival and growth. Maternal pheromones are secreted and the piglet is able to suckle in the presence of maternal pheromones. The piglet also is able to recognize its mother by her odor signature. The third phase is the lactation phase in which sows and piglets organize suckling with an interval of 40 to 50 min between nursing bouts. As piglets become larger, they will have larger, but less frequent meals - this trend continues from birth through market age. If given the opportunity, sows will spend less time with piglets as lactation progresses. The fourth phase is the weaning phase which can be gradual or abrupt and includes weaning and the weaning to estrus interval. Natural weaning by the sow can take place at any time from 3 d to 6 months of age. Sow genotype and the housing system can have major impacts on pig behavior during each phase. Weaning age will significantly impact phase 3 and 4 sow behaviors. Sow welfare including stress-related behaviors, wounds, scratches, injuries, weight loss and body condition are influenced by the behavior sows express as a result of their genotype, housing system and management practices.

Key Words: Pigs, Lactation, Behavior

361 Field experience with gilt age and lactation length. L. V. Himmelberg*, *Danbred North America, Seward, NE.*

The objective of this presentation will be to relate field experiences regarding the impact of gilt age and lactation length on sow productivity. Over time the largest percentage of females to farrow within a herd are parity one and therefore overall herd productivity is greatly influenced by the results achieved by them. Gilt age and weight at first service have a direct impact on these results. Field observations show that increasing gilt age and weight by approximately 30 days and 20 kilograms respectively, over traditional targets of 210 days and 125 kilograms can improve first parity born alive by as much as .75 pig per litter. Early

weaning programs designed to increase sow productivity and improve health have driven weaning averages below 21 days of age. Many producers have noted that weaning this early has a negative impact on subsequent parity born alive. To explore this, commercial production herds containing Danish genetics were examined. Born alive per litter was treated as a dependent variable and previous lactation length as an independent variable within each herd. The results of this analysis showed an average decrease in subsequent parity born alive of .12 pig per day for each day decrease in weaning average between 21 and 15.

Key Words: Gilt, Lactation

Breeding and Genetics: Genetics Methodology 2

362 Pedigraph 2.0: A software tool for the graphing and analysis of large complex pedigrees. J. R. Garbe* and Y. Da, *Department of Animal Science, University of Minnesota, St. Paul.*

Pedigree graphing and analysis are important tasks in animal breeding and genetics. However, pedigree graphing and analysis are difficult for large complex pedigrees. Pedigraph version 2.0 provides rapid graphical visualization and analysis of large, complex pedigrees with a variety of options and features. The program produces artistic pedigree drawings with options to draw the full pedigree, a summarized pedigree with three options, or an extracted pedigree for a selected individual. The user has control over drawing style, fill color, line color, page size, pedigree size, title of the pedigree, gap between two generations, display of trait status, genotype, or inbreeding coefficient, and the minimal number of offspring required for a family to be included in the pedigree. The program can also calculate inbreeding coefficients for all individuals and the coefficient of coancestry between each pair of individuals. The program has been tested using two large and complex populations for its capability of pedigree graphing and its computational feasibility to calculate inbreeding and coancestry coefficients. The program has not encountered limitations in sample size or complexity of the pedigree. The only limitation encountered so far is the ability to print a potentially huge pedigree drawing. These tests plus over a years trial indicate that Pedigraph could be a versatile and capable tool for pedigree visualization and analysis.

Key Words: Pedigree, Genealogy, Visualization

363 Multiple-breed genetic inference using a heavy-tailed structural model for heterogeneous residual variances. F. F. Cardoso, G. J. M. Rosa, and R. J. Tempelman*, *Michigan State University, East Lansing.*

Multiple-breed genetic models have been recently demonstrated to effectively specify the heterogeneous genetic variances that exist between different beef cattle breed groups. We extend these models to allow for heterogeneous residual variances that may be a function of fixed effects (e.g. sex, breed proportion, or breed group heterozygosity) and random effects such as contemporary groups (CG). We additionally specify the residual distributions to be either Gaussian or based on a heavy tailed alternative such as the Student t , in order to distinguish potential outliers from individuals in high variance environments. For either of these two distributions and their homoskedastic counterparts, we analyzed 22,717 post weaning gain records from a Nelore-Hereford population based on a Markov chain Monte Carlo animal model implementation. The heteroskedastic Student t error model (with estimated degrees of freedom 7.33 ± 0.48) was clearly the best fitting model based on a Pseudo-Bayes factor criterion. Sex and breed group heterozygosity, but not breed proportion, appeared to be marginally important sources of residual heteroskedasticity. Specifically, the male residual variance was estimated to be 1.13 ± 0.09 times that for females whereas, for example, the residual variance in F_1 animals was estimated to be 0.70 ± 0.16 times that for purebreds. The CG effects were important random sources of residual heteroskedasticity; that is, the standard deviation of ratios of CG-specific residual variances relative to the baseline average was estimated to be 0.72 ± 0.06 . Purebred Nelores were estimated to have a larger genetic variance ($124.87 \pm 21.75 \text{kg}^2$) compared to Herefords ($40.89 \pm 6.70 \text{kg}^2$) under the heteroskedastic Student t error model; however, the converse was observed from results based on a homoskedastic Student t error model ($46.24 \pm 10.90 \text{kg}^2$ and 60.11 ± 8.54

kg^2 , respectively). These results naturally have important implications for multiple breed genetic evaluations.

Key Words: Bayesian Inference, Genetic Predictions, Outlier Robustness

364 Genetic evaluation of male fertility using a threshold model with emphasis on accurate estimation of conception rate. G. Abdel-Azim*¹, S. Schnell¹, G. Gelbert¹, and H. Rycroft², ¹*Genex Cooperative, Inc., Shawano, WI*, ²*Cooperative Resources International, Shawano, WI.*

A threshold model for male fertility evaluation was applied to a data set of size 2,233,377 records. The model included herd, year-season, bull age, cow parity, as fixed factors, and service bull, inseminated cow, and inseminator as random factors. Variance components estimated as ratios of the total phenotypic variance were 2.8, 11.1, and 5.2% for service bull, cow and inseminator, respectively. The main objective of the study was to transform bull solutions into percentages of conception rates, a more interpretable value to indicate male fertility. The transformation implemented avoids problems arising when linear combinations of estimates are used in a nonlinear parametric function, a practice that is currently in use to report national calving ease evaluations estimated by a threshold model. The transformation we implemented takes into account the accuracy of estimating breeding values and other factors in the model, hence, current practices that do not take accuracy into account were shown to consistently overestimate the probability of success in the binomial setting studied.

Key Words: Fertility, Conception Rate, Genetic Evaluation

365 Application of a random regression model to gene expression profiling. S. L. Rodriguez-Zas*, J. J. Looor, J. K. Drackley, and H. A. Lewin, *University of Illinois, Urbana.*

The patterns of gene expression recorded on individuals over a period can be studied using discrete or continuous representations of time. Within the later representation, the profile of expression can be modeled using common (fixed) and individual (random) polynomial coefficients in time. We evaluated the potential of random regression models to describe the fluctuations in the gene transcription levels recorded at successive time points. The data consisted of fluorescence intensities on more than 6000 unique genes recorded using spotted cDNA microarray technology. Liver samples were obtained at -65 d, -30d, -14d, +1d, +14d, +28d and +49d relative to calving on 8 Holstein cows. A reference design was implemented with each cow-day sample represented in two reverse-dye microarrays and each gene double spotted on each microarray. Fluorescence intensity measurements on 106 microarrays were filtered for weak signals and were normalized using a log2 transformation on the loess-adjusted values. The random regression model included linear to quartic polynomials on days and accounted for heteroscedasticity between days. Three percent of the genes had at least one significant ($P < 0.0001$) regression coefficient in days. The majority of these genes had significant quadratic trends alone or in combination with a significant quartic trend. Hierarchical and disjoint clustering of these coefficient estimates indicated the presence of 5 clusters. Four of these clusters were approximately characterized by significant (positive and negative) quadratic regression coefficients in combination with significant (positive and negative) quartic regression coefficient within each signed quadratic group. The last cluster was characterized by significant linear and cubic regression coefficients. Results from this study

indicate that random regression models are flexible to accommodate the variation in patterns that can be observed in genomic studies.

Key Words: Gene Expression, Random Regression, Clustering

366 Evaluation of three statistical methods for QTL analysis. J. Xu*, J. R. Garbe, N. R. London, Y. Mao, and Y. Da, *Department of Animal Science, University of Minnesota, St. Paul.*

Three statistical methods are widely used in QTL analysis: mixture model (MM) likelihood analysis, regression on genotypic probabilities (RGP) and the least squares method (LS). We evaluated these three methods for statistical power in QTL detection and for accuracy in parameter estimation using simulations. Additive and dominance effects were simulated separately under each method. Three significance levels were used for QTL detection under LS. Critical values for QTL detection under MM and RGP were determined by empirical type-I errors that are equivalent to those under the LS method to ensure fair comparison. Statistical power was measured by the percentage of significant results. Accuracy of parameter estimation was measured by the mean squared error (MSE) of the estimates. For detecting additive effect, LS had the highest power when the heritability of the trait is <0.1 , and the three methods had similar power for higher heritabilities. For detecting dominance effect, MM and RGP had the same higher power and LS had the lowest power. For estimating marker-QTL recombination frequency based on the testing for additive effect, LS had the best accuracy (smallest MSE), followed by RGP, with MM having the worst accuracy. For estimating marker-QTL recombination frequency based on the testing for dominance effect, RGP had the best accuracy and MM had the worst accuracy when dominance heritability <0.1 . The three methods had similar accuracy when dominance heritability is >0.1 . For estimating additive effect, LS had the best accuracy followed by RGP. MM had the same accuracy as RGP when heritability is >0.1 but its accuracy rapidly worsens as heritability decreases. For estimating dominance effect, the three methods had similar performance when dominance heritability is >0.1 but the accuracy of MM rapidly worsens as dominance heritability decreases. These results suggest that each of the three methods has its own strength and that the three methods could be used jointly to complement each others strength.

Key Words: Mixture Model, Regression, Least Squares

367 Relationship between the choice of a random regression model and the possible shapes of the resulting variance function. S. D. Kachman*, *Department of Statistics, University of Nebraska, Lincoln.*

Random regression models provide a flexible means of modeling a trait, measured at variable points in time, using a relatively small number of covariance parameters. Random regression models have been applied in a variety of settings, including modeling lactation curves and growth curves. Within the class of random regression models, models using polynomials have proven to be very popular. The variance as a function of time can be obtained using the variance function, a linear transformation of a set of component variance functions. The component variance functions are not dependent on the variance components. In the case of polynomials the component variance functions are polynomials in time. An examination of the component variance functions, along with the restriction that a covariance matrix for the random regression coefficients must be positive semidefinite, results in the variance function having a lower bound formed by polynomials of even power. This results in a tendency for the variance to grow rapidly for extreme time points. For growth curve models without a fixed endpoint, a major consequence is large genetic and environmental variances for extreme ages. A secondary consequence is the tendency for variance functions to display a rounded wave pattern at intermediate time points. Regardless of the type of function used in a random regression model, the shapes of the component variance functions will determine the possible shapes of the variance function. Understating the component variance functions is important both in determining the suitability of a random regression model and in interpreting the resulting covariance matrices.

Key Words: Mixed Models, REML, Random Regression

368 Weighting of information when predicting breeding values using the standard or marker-based inverse of the numerator relationship matrix. A. Maiwashe*, D. J. Garrick, and R. M. Enns, *Colorado State University, Fort Collins.*

Best linear unbiased prediction uses information from relatives when evaluating the genetic merit of an animal by accounting for additive genetic relationships among animals. Relationships among animals are usually computed using pedigree information (A_p). Relationships among animals can now be computed using genetic markers (A_m). The objective of this study was to derive weights for an individual and its relatives when the A_p or A_m numerator relationship matrices were inverted and used in the mixed model equations. A hypothetical data set for a trait measured on females included one grandsire with half sib sons. The grandsire and his sons had several hundred daughters with yield deviations (DYD). Estimated breeding values (EBV) were obtained using a sire model. The EBV for each son was expressed as a linear function of his DYD if available and EBV of his relatives. The weights for a half-sib bull using A_p were always zero except for his DYD and the grandsire. The relative emphasis on the DYD increased as the number of daughters increased. The zero weight on half-sibs was a feature of the inverse of the A_p . In any non-inbred population, the A_p uses a relationship of 0.25 between all half-sibs. A bull with no daughters was evaluated as half its sires EBV. Its reliability is limited because there can be no accounting for Mendelian sampling. In contrast, the relationship between half sibs can vary from 0 to 0.5 in A_m . That resulted in an inverse with more non-zero coefficients than existed when A_p was used. Accordingly, the evaluation of any particular half-sib had non-zero weights for all half-sibs with the weight on each half-sib varying with the proportions of alleles shared in common. A bull with no daughters could be more reliably assessed using A_m rather than A_p if he had half sibs with daughters because the inferiority or superiority of his Mendelian sampling could be assessed to some extent. The use of relationships based on markers may be advantageous for young bulls.

Key Words: Relationship Matrix, Marker-Assisted Selection, BLUP

369 A practical longitudinal model for evaluating growth in Gelbvieh cattle. K. R. Robbins*, I. Misztal, J. K. Bertrand, A. Legarra, and S. Tsuruta, *University of Georgia, Athens.*

Using Gelbvieh records spanning 1972-2001, the practicality of using a longitudinal model to evaluate growth in beef cattle was examined by subjecting the data to multiple-trait (MT) and random regression (RR) analysis. Approximately 15% of the animals in the dataset had at least one record measured outside of the accepted MT age ranges for weaning weight (WW) and yearling weight (YW). Fourteen percent of WW records and 19% of YW records were measured outside of the accepted ranges for MT analysis. This suggested that a longitudinal model could provide additional information for breeding value (BV) prediction. Three RR evaluations were performed using cubic Legendre Polynomials. The first (RR1), included only records measured within MT ranges. The second (RR2), used records as in RR1, but ages were set to 205 days and 365 days for WW and YW respectively. This was done to determine the extent to which the spread in days at weighing affected the predicted BVs. Finally, the third evaluation (RR3) utilized all available records. Due to convergence problems the random regression parameters were diagonalized via eigenvalue decomposition. After diagonalization, it was found that all models converged in a similar number of iterations. Correlations were computed between model predictions for fixed, direct, maternal, and maternal permanent environmental effects. Correlations between the MT, RR1, and RR2 evaluations were high for all effects. Correlations of MT with RR1 and RR2 for the direct effect were $\#8805$.99 for all three traits, leading to the conclusion that both models were equivalent when predicting BVs from data containing records measured within the MT age ranges. Correlations between MT and RR3 were .992, .958, and .951 for BW, WW, and YW. These correlations show that the added information does affect BV prediction. The results of this study indicate that the RR model has increased capability at a cost similar to MT.

Key Words: Legendre Polynomial, Random Regression, Multiple Trait

Companion Animals

370 Effect of breed and size of dog on body composition. C. J. Cupp, DVM, MS* and G. Czarnecki-Maulden, PhD, Nestle Purina Research, St. Louis, MO.

The objective of this study was to evaluate body composition in small breeds of dogs as compared with larger breeds. Body composition by Dual Energy X-ray Absorptiometry (DEXA) was performed in 34 adult small and toy breed dogs. Results were compared with data obtained from 41 Beagles and 6 Labrador retrievers. Body weight, bone density, total calcium, fat grams, lean grams and bone mineral content were significantly lower in small dogs than in larger breed dogs, which were directly related to their body size. However, small dogs showed a higher percentage of bone and lean tissue, and lower percentage of fat tissue relative to larger breed dogs. Age, gender and reproductive status may influence the differences seen in these parameters and warrants further study.

Key Words: Dog, Body Composition

371 Influence of age on flatulence in dogs. C. Apanavicius*¹ and G. Czarnecki-Maulden², ¹University of Illinois, Urbana, ²Nestle Purina Research, St. Joseph, MO.

Digestive function is thought to decline in elderly animals. One indicator of digestive function is flatus production. The objective of this trial was to determine the effect of aging on flatulence in the dog. Twenty young adult (15 years old, mean age 2.6 years) and twenty elderly adult (8-14 years old, mean age 12.2 years) beagle dogs were used in the trial. All dogs were fed a nutritionally complete extruded dog food. Three hours after meal consumption, a hydrogen sulfide (H₂S) monitor was placed in a vest worn by the dog. Hydrogen sulfide is the main component of flatulence in dogs. Hydrogen sulfide concentration (ppm) was measured by the monitor at 4-second intervals. There was no statistically significant ($P>0.05$) difference in number of flatulence events, peak H₂S, or average H₂S per event in young adult vs. elderly dogs. Therefore, flatulence, as measured by H₂S expulsion, was not affected by aging in beagle dogs. Further research is needed to determine whether other indicators of digestive function are influenced by aging in the dog.

Key Words: Dog, Digestion, Aging

372 Management of canine food intake to reduce obesity. D. Mattsson* and L. Deffenbaugh, Kemin Nutrisurance, Inc., Des Moines, IA.

Obesity in pets is a significant veterinary health issue that manifests in over 40% of dogs and cats that are seen by veterinarians. Most obesity is due to over feeding at mealtime and to owners providing unnecessary snacks to their pets. Unfortunately, veterinarians estimate that they have been successful in treating obesity in only about 10% of cases. One reason for the lack of success might be the difficulty that pet owners have with compliance to a strict feeding program. Pet owners that wish to help their pet lose weight might find a dietary supplement that impacts food intake very helpful in achieving their goal. Cholecystokinin (CCK) is a gastrointestinal peptide hormone that is released from the digestive tract into the circulatory system after consuming food and acts to control short-term food intake. Release of CCK from the digestive tract is stimulated by protein and inhibited by endogenous proteases such as trypsin. Normally, following a meal, the human circulating CCK level can reach 8 pmol/L then decline to a pre-meal level after about 40 minutes. In the absence of proteases, an endogenous releasing factor interacts with cells that produce CCK resulting in stimulation of CCK release. Canine digestive physiology is very similar to humans, particularly with respect to CCK release and serum levels after food consumption. The canine basal CCK level is about 2 pmol/L which rises to a peak of 5-11 pmol/L within 30-45 minutes of the start of food consumption. The serum CCK level then declines to the basal level about 120 minutes after the start of feeding. While exogenous CCK delays gastric emptying, it is not clear whether the increased serum level of CCK following feeding is sufficient to induce satiety. A canine dietary supplement that might temporarily impact short-term food intake may provide pet owners with a means to help their pet consume less food.

Key Words: Canine, Obesity, CCK

373 Meeting the challenge of stabilizing weight management petfood diets. L. B. Deffenbaugh*, Kemin Nutrisurance, Inc.

Weight management diets designed to counter the epidemic of obesity in companion animals abound. For many years, petfood diets for weight reduction have been reduced calorie, reduced fat and / or increased fiber. When fat content is reduced in a petfood diet, special attention must be given to ensure that the limited fat in the formulation meets fatty acid profile requirements. Not surprisingly, the low carbohydrate (high fat and protein) trend in human dietary regimes is also making an appearance in petfoods. In this case, higher fat diets also beg for manipulation of the fatty acid profile to avoid unhealthy excesses of saturated fats. Thus, weight management diets are carefully formulated for not only the amount of fat but also the types of fat. Regardless of the formulation approach for weight reduction diets, whether low or high fat, the ratio of healthy, unsaturated fats will be increased at the expense of unhealthy, saturated fats. Unsaturated fats, especially vegetable and marine oils, are notoriously difficult to protect against autoxidation, and oxidized lipids will cause more harm than the best of intentions for meeting an ideal fatty acid profile. Low fat diets also pose the seeming paradox of being more difficult to stabilize than medium or high fat diets. The chief consideration with increased use of unsaturated fats is selection of the appropriate antioxidant. Recent research has shown that rosemary extract is uniquely suited for highly unsaturated diets, and especially diets relatively low in total fat. For example, the shelf-life stability of a diet with only 8% total fat in which most of the fat was from highly unsaturated menhaden oil was more than doubled by treating the oil with rosemary extract compared to equivalent actives from mixed tocopherols, the most commonly used natural antioxidant. Further, rosemary extract has positive consumer appeal equivalent to the perceptions of fresh, healthy, natural and holistic diets. Proper selection of antioxidants and other strategies to ensure oxidative stability of weight management diets throughout the entire shelf-life will be detailed.

Key Words: Rosemary Extract, Unsaturated Oils, Shelf-Life

374 Diet and age affect canine small intestinal and colonic gut morphology. K. N. Kuzmuk*, K. S. Swanson, L. B. Schook, and G. C. Fahey, Jr., University of Illinois, Urbana.

The objective of this experiment was to determine the effects of diet and age on gut morphology in healthy dogs. Small intestinal villus width, height, and area, and small intestinal and colonic crypt depth were measured. Twelve senior (age = 12 yr old; 6 M, 6 F) and 12 young adult (age = 1 yr old; 6 M, 6 F) beagles were randomly assigned to one of two dietary treatments: an animal product-based diet (APB) and a plant product-based diet (PPB). The APB diet was primarily composed of highly digestible, animal-derived ingredients and was formulated to contain 30% crude protein and 20% fat. The PPB diet was primarily composed of plant-derived ingredients and was formulated to contain 22% crude protein and 8% fat. In addition to dietary protein and fat differences, total dietary fiber was greater in the PPB diet (15.2%) compared to the APB diet (4.8%). Diets were fed for one year. Intestinal sections were collected from the duodenum, jejunum, ileum, and colon and placed in formalin for preservation. Tissues were embedded in paraffin and cut into 3 mm sections, and placed on glass slides. Digital images of tissues were taken using a Nikon Optiphot-2 microscope (Nikon, Melville, NY). Height and width measurements, a minimum of 15 per section, were taken using Image Pro Plus[®] software. Jejunal and ileal villus height, and duodenal villus width were greater ($P<0.05$) for dogs consuming the PPB diet. Age also affected gut morphology as young dogs had greater ($P<0.05$) jejunal villus height while senior dogs had greater ($P<0.001$) colonic crypt depth. Thus, both diet and age affect small intestinal and colonic morphology of the dog. This research was supported by Pyxis Genomics, Inc.

Key Words: Dog, Gut Morphology, Aging

375 Evaluation of glycylysarcosine and cefadroxil as substrates for non-invasive determination of canine small intestine PepT1 capacity and demonstration that maximal cefadroxil absorption occurs when consumed 4 h after meal ingestion. B. M. Zanghi*¹, G. L. Sipe¹, G. M. Davenport², and J. C. Matthews¹, ¹Department of Animal Science, University of Kentucky, Lexington, ²The IAMS Company, Lewisburg.

Glycylysarcosine (GlySar) and cefadroxil (Cef) are reputedly poorly-metabolized substrates of PepT1, the low affinity, H⁺-coupled, peptide cotransporter expressed in the apical membranes of enterocytes. To non-invasively study PepT1 functional capacity in dogs, 50 μ Ci of GlySar (12.5 nmols) or Cef (50 nmols) was orally bolused in a gel capsule to adult, intact female, mongrel dogs to characterize the amount, form, and time required for ³H appearance in blood, urine, and feces. A pilot study (n = 3) demonstrated that GlySar was well absorbed (97.6 versus 2.4% of total ³H was recovered within 24 h after bolusing in plasma versus feces, respectively), but GlySar accounted for only 11.5 \pm 7.8% of serum ³H and 161 \pm 9 d was required for clearance of ³H from plasma (17.3 d half-life). In contrast, Cef was poorly metabolized, and cleared from plasma, urine, and feces within 27 d. Therefore, a 4 x 4 Latin Square experimental design with 35 d periods was performed using dogs (n = 4; BW = 21.3 \pm 2.5 kg) to evaluate the influence of time of Cef bolusing after meal ingestion (0-, 2-, 4-, 6-h) on appearance, metabolism, and clearance of bolused Cef as an indicator of relative PepT1 absorption capacity. Plasma content of Cef (pmol) from 1.5 through 12 h was 530 to 43% greater (P < 0.10) for the 4-h treatment than for the 0-h. Quantitatively, the 4-h after meal ingestion treatment also was 111 to 22% and 60 to 9.4% greater than the 2- or 6-h treatments, respectively. For all bolus treatments, 89 to 95% of serum ³H was in the form of Cef within 1.5 h after dosing. No treatment effect was observed for plasma or urine ³H clearance, and the mean plasma ³H half-life was 6.3 d. These data demonstrate that Cef is a useful marker to evaluate in vivo PepT1 functional capacity and is maximally absorbed when consumed 4-h after ingestion.

Key Words: Dog, Biological Transport, Antibiotic

376 Digestibility of dry dog kibble containing spray dried animal plasma. C. J. Hammer, J. D. Quigley, J. C. Campbell, J. D. Crenshaw*, and L. E. Russell, APC, Inc., Ankeny, IA.

Addition of spray dried animal plasma (SDAP) to diets of farm animals improves feed efficiency; however, there are few data with companion animals. Objective of this study was to determine effects of SDAP on intake and digestibility in dogs. Nine adult Beagle dogs (initial BW = 11.7 kg) were used in a replicated 3 x 3 Latin Square design with 10-d periods. The final five days of each period were used for measurement of intake and fecal collection. A dry dog kibble was prepared and SDAP was added at 1% of the mixture either by blending with other ingredients prior to extrusion, or by blending with fat and applying on the outside of the kibble. Intake and apparent digestibility of nutrients were determined. Addition of SDAP did not markedly affect chemical composition of diets. Intake of dog food was unaffected by treatment; however, intake of DM tended to be reduced (P = 0.09) by 9 g/d when SDAP was added to the diet. Digestibility of DM was improved (P = 0.02) when SDAP was included in the diet. Crude protein digestibility was improved (P < 0.01) by 4.6 and 3.8% when SDAP was added to the kibble pre- or post-extrusion, respectively. Digestion of ash also was improved (P < 0.01) by 11.0 and 10.9% when SDAP was added to the kibble pre- or post-extrusion, respectively. Digestibility of energy tended to be increased (P = 0.07) when SDAP was included in the diet. Digestibility of total dietary fiber was decreased (P < 0.01) by 3.5% when SDAP was applied pre-extrusion and decreased by 9.4% when SDAP was included post extrusion. Although digestibility of total dietary fiber was decreased, fecal weight was reduced an average of 23 g/d and fecal DM excretion was reduced an average 18.5% when SDAP was added to the kibble. In conclusion, spray-dried animal plasma was an acceptable ingredient in this dry dog food preparation and improved digestion and reduced fecal output.

Key Words: Canine, Plasma, Digestibility

377 Chemical composition, bioavailability, palatability, and digestibility of alternative protein sources for dogs. J. M. Dust*¹, C. M. Grieshop¹, C. M. Parsons¹, N. R. Merchen¹, J. D. Quigley, III², and G. C. Fahey, Jr¹, ¹University of Illinois, Urbana, ²American Protein Corp. Inc., Ankeny, IA.

Eleven proteinaceous ingredients (chicken protein sources, blood protein sources, enzyme hydrolyzed fish protein concentrate (EHFPC), soybean meal (SBM), and spray dried pork liver (SDPL)) were analyzed for chemical composition and biological availability. Chicken protein sources ranged in concentrations of CP, acid hydrolyzed fat, and total amino acids (TAA) by 20, 31, and 24%, respectively, and GE by 1.7 kcal/g. Blood proteins ranged in concentrations of CP and TAA by 11 and 8%, respectively. Protein solubility differences within chicken and blood protein source categories averaged 57 and 69%, respectively. Protein solubility of EHFPC, SBM, and SDPL was 53, 67, and 26%, respectively. Calculated lysine digestibility (using immobilized digestive enzyme assay) ranged approximately 16 and 24% for blood and chicken protein sources, respectively. Lysine digestibility values for SBM and SDPL were 89 and 77%, respectively. A chick protein efficiency ratio (PER) assay indicated that chicken protein sources, EHFPC, SBM, and SDPL were highly available (PER value > 2.8) and blood protein sources were poorly available (PER values < 1.5). An experiment to determine palatability and digestibility of a diet supplemented with 0 or 3% processed red blood cells (PRBC) fed to canines was conducted. Palatability data indicated an intake ratio of 0.34 for the 3% PRBC diet. Total tract nutrient digestibilities of DM, OM, and acid hydrolyzed fat were not different (P > 0.05). Digestibility of CP was higher (P < 0.05) for dogs consuming the 0% PRBC diet than the 3% PRBC diet. These data suggest that chemical composition and bioavailability of alternative protein sources differ greatly among ingredients within the same category. The feeding study data suggest that a PRBC-containing diet is not highly palatable and elicits somewhat of a decrease in protein digestion.

Key Words: Bioavailability, Digestibility, Dog

378 Evaluation of preference and acceptability of 2-hydroxy-4 methylthio butanoic acid (HMTBA) and DL-methionine (DLM) by canine and feline animals. M. Vazquez-Anon*¹ and L. R. Prewitt², ¹Novus International, Inc., St. Louis, MO, ²Prewitt Global Consulting Services, Balwin, MO.

This study was designed to evaluate the preferences and acceptability of an 88% solution of HMTBA (Alimet Feed Supplement, Novus International, Inc.) and DLM (dry 99%) in pet food diets. Three levels of HMTBA (0.05, 0.10, 0.15% in canine and 0.2, 0.25, 0.30 % in feline diets) and two levels of DLM supplementation (0.10, 0.15% in canine and 0.25, 0.30 % in feline diets) were added to a basal diet deficient in methionine (M). The first and second level in canine and the third level of supplementation in feline diets represent commercial levels of supplementation. In a three day preference tests, canine and feline animals preferred (P 0.05) diets containing either of the M sources over the control. Canine gram-intake ratios for M compared to control were 2.07:1, 5.58:1, and 5.13:1 for 0.05, 0.1, and 0.15% HMTBA and 5.32:1 and 4.95:1 for 0.1 and 0.15% DLM concentrations. Feline gram-intake ratios for M compared to the basal diet were 1.67:1, 1.91:1, and 1.85:1 for 0.20, 0.25, and 0.30 % HMTBA and 1.87:1 and 1.63:1 for 0.2 and 0.25% DLM. No differences were found between the M sources at 0.10% and 0.25 % for canine and felines, respectively. Canines preferred DLM 2.5:1 times (P 0.05) over HMTBA when over-supplemented at 0.15 % and felines preferred 1.24:1 times (P 0.05) HMTBA over DLM when fed at 0.3 %. Consumption over a 7-day period with no choice demonstrated no significant differences between basal, 0.1 % HMTBA and 0.1 % DLM in canines. In felines, higher consumption (P 0.05) was observed for 0.25 % DLM (69a g) followed by 0.25% HMTBA (62b g), and control (60b g). Addition of HMTBA or DLM to a canine or feline M deficient diet improves palatability and had no detrimental effect on food consumption.

Key Words: Canine, Feline, Methionine

379 Beneficial effects of mannan oligosaccharide on diet component digestibility and fermentation characteristics in the dog. L. C. Kappel¹, Y. Zhang¹, Y. Marcum¹, W. H. Taylor¹, W. G. Henk¹, P. Jowett¹, C. Hedlund¹, K. E. Newman², H-P. Healy³, and A. Kocher*³, ¹*School of Veterinary Medicine, Louisiana State University, Baton Rouge*, ²*Venture Laboratories, Lexington, KY*, ³*Alltech Inc., Nicholasville, KY*.

Adult Beagles (36) and mixed-strain hounds (4), in 8 groups of 5 dogs each, were used to evaluate organic matter digestibility of 4 diets having no fibrous ingredient (CON), beet pulp (BP), soybean hulls (SH), or cellulose (CEL), with or without 0.11% mannan oligosaccharide (MOS; Bio-Mos[®], Alltech, Inc., Nicholasville, KY). Analyzed total (and soluble) fiber percents, respectively, were: 8.1 (2.4), 15.3 (3.7), 16.7 (1.5), and 15.6 (1.7). The study conducted 6 times involved a 21-d adaptation period and a 5-d total fecal collection period. Insoluble fiber digestibility was greatest for SH diet whereas CON, BP, and CEL diets were similar. Insoluble fiber of SH was about 25% more fermentable than that of BP though nonsignificant. Soluble fiber digestibility was variable and not significantly different among fiber sources. The MOS increased soluble fiber digestibility across all fiber sources ($P < 0.05$; 72.9 vs 61.5%, on average), indicating a strong beneficial effect on microbial metabolism due to increased proliferation of the fermentation microbe population. In vitro fermentation of starch, BP, SH, or CEL was evaluated using inocula from feces of 12 dogs (3 from each of the CON and BP diets with and without MOS). Organic matter digestibility of BP and SH was improved with BP + MOS diet but not CON + MOS diet fecal inoculum, indicating that some adaptation period was required for MOS to lead to changes in microbial metabolism. However, fecal inoculum from dogs fed BP + MOS diet decreased acetate, propionate, and total volatile fatty acids using BP or SH substrates and fecal inoculum from dogs fed CON + MOS diet increased acetate and total volatile fatty acids using starch. Histology revealed the number of colonic mucous secreting goblet cells was greater for BP and SH than CON and CEL diets in response to amount of fermentation not fiber per se. Addition of MOS to dry dog food improved fiber digestibility and altered intestinal fermentation patterns.

Key Words: Canine, Fiber, Manno-Oligosaccharide

380 Effect of Bioplex organic trace minerals on copper, manganese, and zinc status of the canine. L. C. Kappel¹, J. F. Williams¹, G. R. Pettifer¹, H-P. Healy*², and A. Kocher², ¹*School of Veterinary Medicine, Louisiana State University, Baton Rouge*, ²*Alltech, Inc., Nicholasville, KY*.

A 24-wk study was conducted with 20 adult, mixed-strain hounds from five litters, housed two dogs per pen, to compare Cu, Mn, and Zn in serum, liver, and hair when feeding a control (CON) diet with an inorganic trace mineral premix or a diet supplemented with an organic trace mineral premix (OTM; Bioplex[®], Alltech, Inc., Nicholasville, KY) at equal mineral inclusion levels. One dog was removed from the OTM group for non-nutritional causes. Dogs used in this experiment were mature with low mineral requirements and adequate mineral status prior to the study. By analysis, the commercial dry basal diet (Animal Nutrition, Ogden, UT) had 10 ppm Cu, 29 ppm Mn, and 56 ppm Zn. Typical industry levels of 8 ppm Cu, 10 ppm Mn, and 140 ppm Zn were added in sulfate form to the CON diet or in proteinate form to the OTM diet. These mineral concentrations were probably above the dogs' mineral requirements. Jugular blood samples (8 mL) were taken at 0, 2, 8, 12, 16, and 24 wk two hours before feeding for serum mineral analysis (stored frozen). Liver samples (15-25 mg) were obtained by liver biopsy at 0, 12, and 24 weeks on test (stored frozen). Two 10 x 10 cm areas on the left side were closely clipped initially, and from one location hair was clipped at the skin at 4, 8, and 12 wk and from the other site hair was sampled at 12 and 24 wk. Over 24 wk, serum and liver mineral concentrations did not differ between diets and were in normal ranges for dogs. Although hair Zn levels did not differ significantly by dietary treatments, the OTM supplemented diet increased hair Cu ($P < 0.05$; 1-4 wk, 17.9 vs 12.9, and 9-12 wk, 11.1 vs 7.2 mcg/g) and Mn (main effect $P < 0.10$; 12.6 vs 9.7 mcg/g) in 4-wk interval hair samples, indicating better Cu- and Mn-proteinate uptake, utilization, different distribution in the body or a combination of the three than Cu and Mn sulfates in the CON diet. Trace mineral availabilities may be more easily demonstrated with growing dogs or those previously deficient, or when using supraoptimal trace mineral inclusion rates.

Key Words: Bioplexes, Canine, Trace Minerals

Extension Education - Dairy Science

381 Impact of conducting a dairy herdsman short-course in California. G. E. Higginbotham*¹, J. H. Kirk², C. C. Collar⁵, A. R. Castillo⁶, S. L. Berry³, B. A. Reed⁷, and J. D. Robison⁴, ¹*University of California Cooperative Extension, Fresno/Madera Counties*, ²*Veterinary Medicine Extension, University of California, Davis*, ³*Department of Animal Science, University of California, Davis*, ⁴*California State University, Fresno*, ⁵*University of California Cooperative Extension, Kings County*, ⁶*University of California Cooperative Extension, Merced County*, ⁷*University of California Cooperative Extension, Glenn County*.

Since 2001, University of California Cooperative Extension (UCCE) has conducted four 18-hour training programs at three different locations for dairy farm employees in the central valley of California. The program consists of classroom and hands-on teaching sessions. Session topics include raising replacement heifers, reproductive management, milking management, nutrition, hoof care, labor management and herd health. Material is presented in English with simultaneous translation for Spanish attendees. Over 120 dairymen, dairy workers and dairy industry representatives have attended the courses. To assess impact of materials taught, a survey was mailed to attendees (N=95) who attended one of the first three herdsman shortcourses and who were thought to have been currently employed on a dairy. Time since attendees attended the shortcourse ranged from 8 - 24 months. The survey was provided in both English and Spanish. Thirty-two former attendees returned the survey (34%). Of those responding, English was the first language for 63%. Of the twelve who indicated Spanish was their first language, only ten used the Spanish questionnaire version. All of the respondents indicated that the course met their expectations (33% strongly agreed; 66% agreed). All but one indicated that they would recommend the course to other herdsman. Nearly 66% of the respondents indicated that Spanish translation of presentations helped in their understanding of the materials. The previous dairy experience of those responding was 0-5 years, 45%; 6-10 years, 22%; and over 10 years, 32%. Overall, 41% of the attendees

indicated that they had begun to apply information they had learned in the classes. Hands-on laboratory exercises were found to be useful to most of the past attendees (calf necropsy, 94%; reproductive tracts, 91%; use of CMT, 91%; cow health, 97%; and foot trimming, 88%). Results from this survey demonstrate the need for a dairy herdsman shortcourse in order for dairy employees to improve their practical dairy skills.

Key Words: Herdsman, Training, Dairy

382 Assessing the Occupational Profiles of Senior- and Middle-level Dairy Managers. R. Stup*, L. Holden, and J. Hyde, *Pennsylvania State University, University Park*.

To effectively prepare dairy managers, educators must have a clear understanding of the competencies that lead to success. A competency is a knowledge or skill that an individual can apply to the successful completion of a task. The first objective of this project was to develop comprehensive sets of job competencies for middle managers and senior managers. These can subsequently be used for developing and updating dairy education curricula. The second objective was to assess the level of proficiency in each of the competencies among the current workforce to prioritize training needs.

Highly successful senior- and middle-level dairy managers were identified by Cooperative Extension educators and dairy industry personnel. These successful managers participated in focus groups with the objective of identifying, describing, and categorizing the competencies that lead to success. Four focus groups were conducted, two senior manager groups with a total of 17 people and two middle manager groups with a total of 12 people. Focus groups were professionally facilitated. The focus groups used a computer aided process known as a Customized Occupational Profile (COP) to identify general competency areas and the specific tasks that must be accomplished within those areas. The data resulting from the focus group processes were combined into comprehensive sets of job competencies for each respective manager position.

A survey was developed to assess the proficiency of existing middle and senior managers, relative to the identified competencies, within the framework of a gap analysis. The survey was distributed to dairy managers and the overall response rate was 37.2%. Respondents were asked to assess their own ability in each of the general competency areas. Competency-based research of this nature is widely used in other industries, but it is rare in dairy. Dairy educators in both Cooperative Extension and resident education will be able to use this information to update and improve educational programs.

Key Words: Dairy, Manager, Competency

383 The evolution of an extension education website - Dairy beef: Maximizing quality and profits. J.C. Dalton*¹, D.A. Moore², J. Kirk², M. Poe², and H. Sullivan³, ¹University of Idaho, Caldwell, ²University of California, Davis, ³New Mexico State University, Las Cruces.

In response to food safety and quality concerns in dairy market cattle, a 7-western state collaborative educational project was developed to create a distance-learning program for dairy producers, Cooperative Extension advisors, and dairy veterinarians to provide a consistent message about dairy beef food safety and quality. Faculty at the University of California, Davis, designed the program with input from dairy and meats scientists, veterinarians, and media specialists from Arizona, Colorado, Idaho, New Mexico, Oregon, and Washington. Individuals are encouraged, but not required, to register to view the website program materials. Between February 2003 and March 2004, 93 individuals registered for the course. According to FlashStats, the monthly page hit totals for March to December 2003 range from 8,904 to 27,412 hits. Following publication of an article about the development of the Dairy beef educational program in the *Journal of Dairy Science*, there were over 8,000 page hits in the first week of January 2004. The curriculum modular format complements the role of Cooperative Extension faculty through flexible delivery via the Internet or by CD ROM. The curriculum also has the versatility to be used in a workshop setting by a veterinarian, or even a dairy owner. Furthermore, the modular format allows for flexibility when adding, changing, or marketing new segments to users. When BSE was found in a dairy cow in Washington, project members were quickly able to assess the situation, find useful, existing links to educate dairy producers and veterinarians, and add new information to the Dairy beef website. In response to suggestions from in-residence programs and website course evaluations, the project team is producing training modules for Spanish speaking dairy employees. Dairy beef: Maximizing Quality and Profits (<http://dairybeef.ucdavis.edu>) is a flexible distance education tool to educate dairy and allied industry personnel about dairy beef food safety and quality.

Key Words: Dairy Beef, Food Safety

384 Businessense: Teaching dairy producers best management practices in business and information management. B. J. Hilty* and L. A. Holden, *Pennsylvania State University, University Park.*

Operating a dairy business involves considerable risk. Financial risk can be managed through sound decision-making. Accurate information concerning business performance is needed for sound decision making. An educational program, Businessense, was developed to improve decision making skills of Pennsylvania dairy producers through the adoption of best management practices in business and information management. This program was an interactive three-session workshop consisting of lectures, hands-on business analysis exercises and group discussions. Forty-five producers participated in the program. Each producer was required to submit data to complete a comprehensive business analysis. Participants also used an Excel spreadsheet, DairyCOPS (Cost of Production System), to calculate their production costs per hundred pounds of milk. Data from both analyses was summarized and presented to participants so they could see where their operation ranked among the sample of farms. Group discussions addressed issues such as investment management, cost control and production efficiency, which were previously addressed in lectures. Five key financial ratios for evaluating business performance and five key production indicators for evaluating herd performance were identified. Participants were given a pre and post test to identify these ten indicators. Less than 10 percent of participants were able to identify more than one correct financial ratio, while less than 20 percent were able to identify more than two key production indicators

on the pre-test. On the post-test over 70 percent of participants correctly identified four to five financial indicators and 98 percent correctly identified four to five production indicators. Businessense effectively taught producers how to implement best management practices in business and information management. Regular analysis of key indicators will positively impact dairies over time through better decisions.

Key Words: Dairy, Business, Management

385 Minnesota 4-H Gopher Dairy Camp: A Youth Learning Experience. B. J. Heins*, L. B. Hansen, and A. J. Seykora, *University of Minnesota, St. Paul.*

The Gopher Dairy Camp provided an exceptional 3-day opportunity for 4-H and FFA youth to participate in dairy showmanship, dairy judging, dairy workshops, and to interact with other youth participants. The camp provided four educational workshops consisting of artificial insemination, dairy heifer nutrition, corrective mating of dairy animals, and linear classification and scoring of dairy cows. The workshops were followed by a 'mock' dairy auction where youth purchased dairy heifers to prepare for the showmanship contests the next day. On the second day, professional dairy fitters were brought in to help teach and assist the campers about the basics of fitting a heifer and dairy showmanship. In the afternoon the youth participated in an ethics training seminar and a showmanship contest followed. A fun evening activity was planned where youth could interact and relax. The evening activity in 2003 was a Minnesota Twins game. The third day involved dairy leaders presenting dairy judging workshops, teaching the basics of dairy judging, which was followed by a dairy judging contest with 3 classes. Program evaluation by youth indicated that the camp was highly successful (4.6 on a 5-point scale). Group Fitting demonstrations (4.5), Activity Night (4.8) and Gopher Gold Auction (4.4) were also highlights among the participants. Approximately 50% of the costs were provided by various dairy industry sponsors and 4-H foundations. Seventy-four youth were registered for the camp and the participants paid a registration fee of \$75. Many alumni and industry professionals made the camp a huge success. Based on the high ratings received, the planning committee decided to continue with the camp into the future. The results indicated the Gopher Dairy Camp was enjoyed by all.

Key Words: 4-H, Youth, Dairy

386 Western integrated nutrition and nutrient management education (WIN²ME) for the nutrition and nutrient management professional. J. H. Harrison*¹, L. M. VanWieringen¹, R. L. Kincaid¹, A. Hristov², R. Sheffield², M. Gamroth³, P. French³, and T. Downing³, ¹Washington State University, Puyallup, ²University of Idaho, Moscow, ³Oregon State University, Corvallis.

The US EPA released new guidelines for Concentrated Animal Feeding Operations and Animal Feeding Operations in 2003. Under the new guidelines, CAFO/AFOs are required to develop a Nutrient Management Plan. One form of a Nutrient Management Plan is a Comprehensive Nutrient Management Plan and is defined in the Natural Resources Conservation Service National Planning Procedures Handbook. There are six components of a CNMP: 1) Feed Management, 2) Manure and Wastewater Handling and Storage, 3) Nutrient Management, 4) Land Treatment, 5) Record Keeping, and 6) Other Manure and Wastewater Utilization Options. Feed represents the largest import of nutrients to the farm, followed by commercial fertilizer. Feeding Management opportunities currently exist to reduce imports of nutrients, particularly nitrogen and phosphorus. The technologies and approaches to achieve these reductions vary in their degree of economic feasibility and environmental impact. Agricultural professionals need to understand the probable impact of changes in feeding management both from an economic and an environmental standpoint. The intended audience is staff of the NRCS, Conservation Districts, Nutrient Management Consultants, Nutrition-Management Consultants, and designated Nutrient Management Specialists of large animal operations. Specific objectives are: 1) provide training to Ag Professionals in feed management concepts and practices that minimize the import of nutrients to the farm and provide economic and environmental sustainability, 2) provide training in the use of computer models and software for strategic ration balancing, whole farm nutrient balance, and whole farm economics, and 3) develop educational materials that are specific to the Pacific Northwest regional

animal industries while utilizing national curriculum developed to address nutrition in the context of nutrient management. The curriculum has been developed using a 101 and 201 level approach.

Key Words: Extension, Nutrient Management, Environmental

387 Use of a dairy whole farm phosphorus balance education tool (dairy WFPBET) to teach dairy producers and their advisers nutrient management concepts at the whole-farm level. J. H. Harrison*¹, T. Nennich¹, and A. Rotz², ¹Washington State University, Puyallup, ²USDA/ARS, University Park, PA.

All dairy farms in the state of Washington are now required by law to have a certified nutrient management plan. These plans are nitrogen based; however, in early 2003, EPA released new CAFO guidelines to require that nutrient management plans consider phosphorus (P) as well. The objective is to encourage producers to actively use their nutrient management plans as a part of their overall farm management. To better prepare producers for this change, a spreadsheet based education tool was developed in Excel to demonstrate whole farm concepts related to nutrient balance with a focus on P. The goals in developing the tool were: 1) to use a simple interface viewed on a single page (worksheet), 2) to use input information readily available on most dairy farms, and 3) to use terminology and calculations consistent with a program developed by NRCS that is used in writing nutrient management plans for Washington dairy farms. The inputs required to determine a farm balance are herd milk production, number of milking cows, dry cows, and heifers, DMI of lactating cows, P content of lactating cow rations, fertilizer import, land in forage crops, yield and P content of forage crops, and estimated availability of P in manure. Output of the analysis includes the manure P available to crops and the whole farm balance of P. This educational tool is used to demonstrate the effects of management changes such as reduction in diet P, level of milk production, custom raising of heifers, forage yield and type, and the use of winter cover crops.

Key Words: Nutrient Management, Environment, Phosphorus

Forages and Pastures: Forages in Dairy Production

389 Grazing behavior of late lactating dairy cows under continuous stocking. H. Z. H. Taweel*, B. M. Tas, J. Dijkstra, and S. Tamminga, *Department of Animal Sciences, Animal Nutrition Group, Wageningen University, Wageningen, The Netherlands.*

This experiment aimed at studying the behavioral strategies grazing dairy cows employ to satisfy their nutritional needs as the day progresses. For this purpose the day was divided into three main periods (6:00 to 12:00 h, 12:00 to 18:00 h and 18:00 to 24:00 h) where the three main grazing bouts (dawn, afternoon and dusk) of dairy cows usually occur. Four late lactating rumen-cannulated dairy cows were used in a repeated measures design, with the grazing bout as the within subjects factor. The cows had access to a 1-ha grass sward under a continuous stocking system, which assured ad libitum herbage allowance. To estimate dry matter intake (DMI), bite rate, bite mass (BM) and intake rate at the three bouts, cows were rumen-evacuated at 6:00, 12:00, 18:00 and 24:00 h and jaw recorders were fitted to the cows between these time points. Time spent eating by dairy cows at the dusk grazing bout was much longer ($P < 0.05$) than that at the other two grazing bouts and made about 40 % of the daily total eating time. Total grazing jaw movements (TGJM) rate was constant during the day at around 75/min. Bite rate increased ($P < 0.05$) from 54 to 61/min, but chewing rate decreased ($P < 0.05$) from 20 to 16/min as the day progressed. BM (mg DM/bite) increased ($P < 0.05$) from 400 to 563 as the day progressed, but that was not due to increased bite dimensions, rather it was due to increased DM content of the grass at dusk time, which increased from 19 to 25%. Consequently, both intake rate and DMI increased ($P < 0.05$) from 22 to 34 (g DM/min) and from 3 to 7 (kg/bout) during the dawn and dusk grazing bouts, respectively. Therefore, it could be concluded that the main behavioral strategies dairy cows employ to satisfy their nutritional needs under continuous stocking include manipulating

388 The feeding of dietary phosphorus on dairy farms in the Lake Champlain Basin. K. W. Cotanch*¹, C. S. Ballard¹, W. C. Emerich¹, C. J. Sniffen², and E. D. Thomas¹, ¹W.H. Miner Agricultural Research Institute, Chazy, NY, ²Fencrest LLC, Holderness, NH.

Nutrient balance on dairy farms is critical in efforts to maintain and improve water quality in the Lake Champlain Basin. Reducing dietary phosphorus (P) levels to dairy cattle will reduce phosphorus loading of cropland from manure application. A survey of feed consultants operating in Vermont showed recommended P levels for cows producing 30 kg/d varied: 0.48 to 0.55% from five feed company consultants; 0.44% from an independent consultant; and 0.37% from the University of Vermont nutritionist. At current feeding rates, P is being fed in excess of requirements (0.32 to 0.38%). The objective of the study was to obtain baseline information about current P feeding practices on farms; farmers understanding of the nutritional requirements for P; and their attitudes about the economic and environmental importance of P reduction on dairy farms in the region. Thirty farms located in the Champlain Basin were randomly selected with weight given to farm size and facility design. Farms varied in size (100-1000 cows), facility structures and management styles from both New York and Vermont (15 per state). A 10 question survey indicated that farmers were agreeable to reducing dietary phosphorus levels, but not fully aware of the new NRC 2001 P recommendations. Only 50% of the producers claimed to know the level of P they were currently feeding. Nutritionists dietary P formulations were compared with wet chemistry analyses of diets. Only 21% of diets formulated for lactating cows were balanced for <0.40% P with ranges from 0.36-0.50%. Analyzed TMRs found that 38% of rations were <0.40% P, ranging from 0.28-0.57%. The wide variation between P levels balanced for and that actually being fed may be attributed to imprecise measurements of P in forages on the farm and feeds sold to the farm. Grain components used to manufacture feeds vary greatly in P levels and may not be accurately accounted for in ration formulation. Farm size was a critical factor in the frequency of forage testing and overall nutrient management. Larger farms had forages analyzed more than twice as often as smaller farms and were more positive to the economic savings of reducing dietary P levels.

Key Words: Phosphorus, Nutrient Management, Dairy Cattle

their eating time, biting rate and chewing rate, with little control over TGJM rate and BM.

Key Words: Grazing Behavior, Intake Rate, Bite Mass

390 Modeling pasture-based split-calving dairy systems using a whole farm model. P. C. Beukes*¹, B. S. Thorrold¹, M. E. Wastney¹, C. C. Palliser¹, J. A. S. Lancaster¹, C. F. Folkers¹, G. L. Levy¹, M. Neal^{2,1}, and M. J. Auld³, ¹Dexcel Ltd., Hamilton, New Zealand, ²University of Sydney, Sydney, Australia, ³Department of Primary Industries, Ellinbank, Australia.

Traditional New Zealand dairy systems are based on spring calving with drying off in autumn to match cow demand with pasture growth. Split-calving involves a proportion of the herd calving out-of-season (e.g. in autumn) with the aims of coping better with dry summers, reducing wastage in cows which fail to get in calf on a 12-month cycle and to benefit from a winter milk premium. A farm systems modeling approach was used to investigate feed flow and economic impacts of split calving. The first step was to calibrate the predicted lactation curves of a computer model (the Whole Farm Model; WFM) against observed data from a trial where different herds were calved in winter, spring, summer and autumn over a three-year period. Introducing a photoperiod effect on lactation hormone levels into the cow component of the model (known as "Molly"), significantly ($P < 0.01$) reduced the average prediction error for milk yields (before adjustment = 4.52, SD 1.598 kg; after adjustment = 2.77, SD 0.749 kg). The WFM was then used to compare milk fat and protein (milksolids; MS) production, silage conservation and feeding and economics (in NZ\$) between a spring-calving (July) system and a 50:50 spring-autumn (May) split-calving system over five different climate years (1998-2002). At a similar stocking rate the split-calving herd produced 9.4 kg MS/cow and 28.8 kg MS/ha more ($P < 0.001$) than the spring-calving herd, but with no significant difference in silage

costs (\$146/ha, SD \$43 vs \$144/ha, SD \$35). The winter milk premium of \$180/ha (@ \$0.8/kg MS) for the split-calving herd contributed to a significantly ($P < 0.001$) higher economic farm surplus (\$2602/ha, SD \$253) compared to the spring-calving herd (\$2370/ha, SD \$236).

Key Words: Model, Farm Systems, Economics

391 Effects of feeding legume silage with differing tannin levels on lactating dairy cattle. U. C. Hymes-Fecht*, G. A. Broderick, R. E. Muck, and J. D. Graber, *U.S Dairy Forage Research Center, Madison, WI.*

Silages made from Birdsfoot trefoil (BFT) containing three different levels of condensed tannins (CT) were compared to alfalfa (ALF) and red clover (RC) silages as forage sources. Twenty-five lactating Holstein cows (5 fitted with ruminal cannulae) were randomly assigned to incomplete 5X5 Latin squares to assess the effects on milk production and N utilization. Diets contained (DM basis) 50% of ALF, RC or one the 3 BFT that contained low (LTBFT), normal (NTBFT) or high (HTBFT) concentrations of CT. There were differences in CP among silages: ALF and LTBFT were highest, NTBFT and HTBFT intermediate, and RC lowest. The levels of NDF were higher in RC and ALF than in the BFT silages. There were no differences in DM intake or in milk composition due to silage source. However, yield of milk and FCM was higher on NTBFT and HTBFT than LTBFT, which was higher than that on ALF and RC. Fat yield was 0.19 kg/d higher on NTBFT than on ALF, with the other 3 diets being intermediate. Protein yield on all 3 BFT diets, regardless of CT level, was higher than on ALF and RC, despite the fact that the BFT diets contained about 1% less CP. MUN was lower on NTBFT and HTBFT than on LTBFT, ALF and RC. Differences in milk yield may have been confounded by the BFT diets being lower in fiber (27% NDF) than the ALF and RC diets (29% NDF). However, these results suggest CT concentration was directly related to improved utilization of CP in BFT silages.

Item	ALF	RC	LTBFT	NTBFT	HTBFT	SE	P value
Forage NDF, % of DM	35.3 ^b	42.7 ^a	32.4 ^c	32.4 ^c	32.2 ^c	0.4	<0.01
Forage CP, % of DM	22.0 ^a	18.1 ^c	21.7 ^a	20.4 ^b	20.1 ^b	0.3	<0.01
DMI, kg/d	24.4	25.6	25.2	23.3	24.5	0.7	0.41
Milk, kg/d	30.2 ^c	31.1 ^c	32.9 ^b	34.6 ^a	34.3 ^a	0.5	<0.01
3.5% FCM, kg/d	31.4 ^d	32.6 ^{cd}	33.8 ^{bc}	36.3 ^a	35.3 ^{ab}	0.6	<0.01
Fat, kg/d	1.13 ^c	1.17 ^{bc}	1.20 ^{bc}	1.32 ^a	1.24 ^{ab}	0.03	<0.01
Protein, kg/d	0.94 ^b	0.96 ^b	1.04 ^a	1.09 ^a	1.07 ^a	0.02	<0.01
MUN, mg/dl	10.8 ^a	11.0 ^a	10.8 ^a	9.3 ^b	9.2 ^b	0.3	<0.01

^{a,b,c} Means within a row with unlike superscripts differ ($P < 0.05$)

Key Words: Condensed Tannins, Birdsfoot Trefoil, Red Clover

392 Protective coatings for the edible covering of bunker silos. L. L. Berger* and J. R. Sewell, *University of Illinois, Urbana.*

The objective of this research was to develop a protective coating for the edible starch/salt matrix (SSM) covering for silage. Since the SSM is semi permeable to moisture, an external coating is needed to prevent erosion. A control (6-mil polyethylene plastic covering) was evaluated against three test coatings, sprayable paraffin wax emulsion (SW), molten paraffin wax (MW) and a wax paper (WP; Georgia-Pacific Paper Company, Clatskanie, OR). Eight 2.14 X 7.32 m bunker silos with a packed limestone base and plywood walls were used. Approximately 9695 kg of chopped whole corn plant (39.1% DM) was packed into each silo. The silos were sealed on September 11, 2003 and opened after 117 d of ensiling. Upon opening, the SSM was removed from the surface of the silage and was fed at 2.5% of a corn-corn silage diet for growing steers without refusal. Samples of ensiled forage were collected from depths of 0-15.24, 15.25-30.48 and 30.48-45.72 cm and analyzed for percent sodium content. As seen in previous trials the sodium levels help preserve the silage immediately under the covering. Data were analyzed with proc GLM model in SAS. The percent sodium for the three depths under the control treatment yielded values of 0.02, 0.01, and 0.01%. The sodium values for the SSM with SW, MW, and WP covering were 1.18, 0.80, and 0.44%; 2.18, 1.36, and 0.46%; 0.77, 0.51, and 0.29% at each depth, respectively. The concentration of sodium for the SW, MW, and

WP were significantly different than the control ($P < .05$). The salt aids in the preservation of the silage under the covering, but external coating over the SSM improves preservation. The DM fed for the control, SW, MW and WP treatments were 2497, 1990, 2664, and 2497 kg/silo, respectively. Less DM was fed from control silos than from MW silos ($P < .05$). Less DM was fed from the SW than WP silos ($P < .05$).

Key Words: Corn Silage, Edible Covering, Salt/Starch Matrix

393 Effect of corn cutting height on digestibility and nutrient composition of silage-only and dual-purpose corn hybrids. K. W. Cotanch*¹, E. D. Thomas¹, H. M. Wolford¹, C. S. Ballard¹, R. J. Grant¹, P. Mandevu¹, M. Suekawa², T. Sato², and Y. Yabuuchi², ¹W.H. Miner Agricultural Research Institute, Chazy, NY, ²Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan.

Previous research has found that when cutting height was increased from 15 to 45 cm, milk yield per tonne increased by 9.8% and milk yield per hectare increased by 3.3% (MILK2000 spreadsheet). The objective of this study was to evaluate the effect of corn cutting height on forage quality parameters of silage-only and dual purpose hybrids. Two 95-d relative maturity corn hybrids were selected and planted in a replicated 4-row strip trial: Pioneer 38T27, a dual-purpose hybrid and Mycogen TMF 2450, a silage-only hybrid containing the leafy and Bt genes. Within five field plots, ten plants per plot were selected randomly and harvested 15 cm above the ground. Within plots, each plant had two 15-cm sections of the stalk cut and pooled by stalk section. Samples were chopped to a particle length of 6 to 8 cm and dried at 60°C. Nutrient composition and digestibility were determined and MILK2000 was used to estimate milk yield. Corn silage harvested at 30 and 45 cm had significantly higher milk production potential at the expense of milk production per hectare. The silage-only hybrid gained the most potential milk yield from increasing cutting height from 15 to 45 cm (1777, 1841 kg/tonne) compared with the dual-purpose hybrid (1812, 1851 kg/tonne).

Parameter	15 cm	30 cm	45 cm	SE
Dry Matter, %	36.8 ^c	37.8 ^b	38.5 ^a	<0.1
Yield DM, kg/10a	17,770 ^a	17,291 ^b	16,760 ^c	9
NDF, % of DM	41.4 ^a	40.4 ^b	39.1 ^c	<0.1
48-h IVNDFd, %	57.2 ^c	57.8 ^b	58.3 ^a	<0.1
Lignin, % of DM	3.2 ^c	3.1 ^b	2.9 ^a	<0.1
Ash, % of DM	2.9 ^a	2.8 ^b	2.7 ^c	<0.1
Starch, % of DM	36.6 ^c	37.6 ^b	38.8 ^a	<0.1
Sugar, % of DM	5.3	5.2	5.2	<0.1
Milk/Tonne, kg	1795 ^c	1819 ^b	1846 ^a	1
Milk/10a, kg	32,160 ^a	31,721 ^b	31,201 ^c	22

^{abc} Means within a row differ ($P < 0.05$)

Key Words: Cutting Height, Corn Silage, Digestibility

394 Effect of harvest date and brown midrib gene on in situ disappearance of sorghum x Sudangrass hybrids. P. A. Beck*¹, J. M. Phillips¹, S. Hutchison², T. Losi³, C. B. Stewart¹, P. K. Capps¹, and S. A. Gunter¹, ¹Southwest Research & Extension Center, University of Arkansas, Center Hope, ²Dept. of Animal Science, University of Arkansas, Fayetteville, ³Universidade Estadual Paulista Faculdade de Medicina Veterinaria e Zootecnia, Botucatu, SP, Brazil.

Three sorghum x sudangrass hybrids were planted in 12 - 0.2 ha plots to test the effect of date of harvest and the presence of the Brown Midrib (BMR) gene on in situ DM and fiber disappearance. Sweet Sunny Sue, a non-BMR hybrid, and the BMR hybrids Nutri + Plus BMR and MS505DS were planted at 22.4 kg/ha using a no-till drill. Plants in ten 0.5 m² quadrants per plot were hand-clipped to 2.5 cm height at weekly intervals beginning 34 d after planting. Samples were dried at 50° C, ground to pass a 2 mm screen, and samples from d 34, 48 and 63 were composited within plot for determination of N, NDF, ADF, and in situ disappearance of DM, NDF, and ADF. The in situ disappearance study was conducted using three ruminally cannulated steers (BW = 584 kg ± 10.4) in a 3 x 3 Latin-square design. Samples from each harvest date were incubated for 6, 12, 24, 36, 48, 72, 96, and 120 h in a single steer during each period of the Latin square. Disappearance

kinetics were analyzed using PROC NLIN in SAS the resulting data was analyzed as a Latin-square design using PROC MIXED in SAS. Forage quality was analyzed as a completely random design using PROC GLM in SAS. The BMR varieties were lower ($P < 0.01$) in ADF and NDF at all harvest dates, while N concentrations were not affected ($P > 0.41$) by variety. The A fraction of DM and NDF was higher ($P < 0.01$) and the C fraction of DM, NDF, and ADF was lower ($P < 0.01$) for BMR than non-BMR. The B fraction of DM was not affected ($P = 0.15$) by variety, while the B fraction of ADF was higher ($P < 0.01$) in BMR than non-BMR. The B fraction of NDF was not different ($P = 0.28$) on d 34, but was higher ($P < 0.01$) on d 48 and 63 for BMR than non-BMR. The A fraction of DM and ADF was higher ($P < 0.01$) and B fraction of ADF was lower ($P < 0.01$) for MS505 DS compared to Nutri + Plus BMR. Rates of DM and NDF disappearance were higher for BMR than non-BMR for all harvest dates ($P < 0.01$). Disappearance of ADF was faster ($P < 0.01$) with BMR than non-BMR on d 48 and 63. Effective degradability of DM, NDF, and ADF was higher ($P < 0.02$) for BMR than non-BMR at all harvest dates.

Key Words: Sorghum x Sudangrass Hybrids, Forage, In Situ Disappearance

395 Effect of genotype and maturity on ensiling characteristics and chemical composition of millet forage. F. Hassanat*, A. Mustafa, and P. Seguin, *McGill University, Ste-Anne-de-Bellevue, QC, Canada.*

A study was conducted to determine the effects of genotype and stage of maturity at harvest on ensiling characteristics, microbial population, and chemical composition of forage millet. Regular (RM) and brown midrib (BM) millet were harvested at vegetative (VS) or heading stage (HS), then ensiled in mini-silos for 0, 2, 4, 8, 16, and 45d in triplicates. Both millet types were well ensiled and had a pH less than 4.2 after 45d of ensiling. Both RM and BM millet harvested at HS had more ($P < 0.05$) water soluble carbohydrates (16.08 and 17.82%) than when harvested at VS (11.13 and 12.25% respectively). This was reflected in lower pH in BM silage harvested at HS compared with those harvested at VS ($P < 0.05$) at any day of ensiling. Most proteolysis occurred between 0d and 8d of ensiling, where 40-50% of true protein (TP) was lost to non-protein nitrogen (NPN) for the two millet types at any stage of maturity. Changes in the microbial population during ensiling were similar for the four treatments. There was an increase in the lactic acid bacteria population in the first 2d of ensiling. Enterobacteria population decreased as ensiling progressed and were not detected after d 8 of ensiling. Yeast and mold populations followed the same trend, but stayed at detectable level up to d45 post-ensiling. Silage made from millet harvested at VS had more yeast at d45 (2.9 log cfu/g) than that harvested at HS (< 2.0 log cfu/g). Silage (45d) made from BM contained less NDF, (55.0 vs 59.2%), ADF (29.1 vs. 31.3%), ADL (1.1 vs. 1.6%) and more CP (8.5% vs. 7.2%) than silage made from RM ($P < 0.05$). For the two millet genotypes, silages harvested at HS contained more ADF and ADL and less CP than silages harvested at VS ($P < 0.05$). It was concluded that silages produced from RM and BM millet at VS and HS of maturity were well preserved as indicated by low pH. Genotype and stage of maturity had significant effects on the chemical composition of forage millet silage. It is concluded that brown midrib millet provides better quality forage than regular millet.

Key Words: Forage Millet, Brown Midrib, Chemical Composition

396 Effect of inoculation on ensiling characteristics and chemical composition of regular and brown midrib millet. F. Hassanat*, A. Mustafa, and P. Seguin, *McGill University, Ste-Anne-de-Bellevue, QC, Canada.*

A study was conducted to determine the effects of inoculation and genotype on ensiling characteristics and chemical composition of two millet types in a 2x2 factorial design. Regular (RM) and brown midrib (BM) millet were treated with commercial inoculum (PIONEER[®] 1129) or left untreated. Forages were ensiled in mini silos for d 0, 2, 4, 8, 16, and 45 in triplicates. For the two millet types, pH at d 2, 4 and 8 was lower ($P < 0.05$) for inoculated than untreated ensiled forages. Lactic acid concentration was higher ($P < 0.05$) in inoculated silage compared to the untreated one at any day of ensiling. At d 45, inoculated BM millet silage had a lower ($P < 0.05$) pH (3.5) than untreated BM (3.7). However, pH of RM silage at 45d was not affected by inoculation. Level of non protein nitrogen at each ensiling time was similar for inoculated and untreated ensiled forage, suggesting minimal effect of inoculation on proteolysis. Inoculation had no effect on the chemical composition of the d 45 silage made from any millet type, except in RM TP% level which was higher ($P < 0.05$) in inoculated (42.42%) than the untreated silage (39.70%). Levels of NPN% and TP% were similar between inoculated treated and untreated BM silage. The RM silage contained lower NPN (54.5 vs. 57.3% CP) and higher true protein (41.1 vs. 38.4 %CP), acid detergent fiber (30.8 vs. 27.8%), and acid detergent lignin (2.1 vs. 1.0%) than BM silage ($P < 0.05$). Both silages had similar CP%. We concluded that inoculation produced a rapid decline in pH and an increase in lactic acid of ensiled forage millet. The d 45 silages were not affected by inoculation, and were all well preserved. Inoculation had minimal effect on chemical composition RM and BM silages.

Key Words: Millet, Brown Midrib, Inoculation

397 Lignin concentration of whole plants and stems of Bt corn hybrids. H. G. Jung*^{1,2} and C. C. Sheaffer², ¹USDA - Agricultural Research Service, ²University of Minnesota, St. Paul.

There have been inconsistent reports regarding whether corn (*Zea mays*) hybrids with the *Bacillus thuringiensis* (Bt) *cry1 Ab* transgene contain more lignin than non-Bt hybrids of similar genetic background. Our objective was to evaluate the potential impact of the *cry1 Ab* transgene on lignin concentration (using three different assays), yield, and forage quality traits of corn silage. Replicated trials were conducted at four locations in Minnesota with 12 commercial hybrids (three MON810 and three Bt11 *cry1 Ab* transgene event hybrids, and respective near-isogenic controls). Whole plants and the fourth elongated, above-ground internodes were harvested at silage maturity. Samples were analyzed for crude protein, starch, neutral detergent fiber (NDF), acid detergent fiber, 24- and 96-h in vitro ruminal NDF digestibility, and lignin (acid detergent, Klason, and acetyl bromide). European corn borers (*Ostrinia nubilalis*) were not controlled and plant damage from this source was limited to the non-Bt hybrids, averaging 1.5 internodes per plant with tunnels. Growth environment impacted all measures of corn hybrid performance and quality, as evidenced by significant location effects. Comparisons of non-Bt/Bt hybrid pairs, for both whole plants and internodes, found no consistent differences in yield, nutrient content, in vitro ruminal NDF digestibility, or lignin concentration. Differences in lignin concentration (for all three analysis methods) were infrequent, small in magnitude, and limited to a few non-Bt/Bt hybrid pairs at individual locations. Bt hybrids were both higher and lower in lignin concentration than their non-Bt counterparts. Two non-Bt/Bt hybrid pairs did not differ in lignin concentration at any location. Contrary to some earlier reports, presence of the *cry1 Ab* transgene did not alter lignin concentration or other forage quality traits of corn stover in commercial maize hybrids.

Key Words: Corn Hybrids, Lignin, Fiber Digestibility

ASAS Growth and Development I

398 Muscle fiber characteristics are important in the relationship between birth weight and carcass quality in pigs. C. Rehfeldt*, G. Kuhn, I. Fiedler, and K. Ender, *Dept Muscle Biology and Growth, Research Institute for the Biology of Farm Animals, Dummerstorf, Germany.*

It is commonly recognized that low birth weight in piglets correlates with decreased survival and lower postnatal growth rates. The aim of this

study was to investigate the relationships between birth weight, carcass quality and skeletal muscle fiber characteristics. At birth, three piglets (lightest, but > 800 g; middle-weight; heaviest) were selected from each of 16 litters. The lightest piglets exhibited the smallest percentages of

meat, total protein, total fat, the lowest *Semitendinosus* muscle (ST) weight and total fiber number, whereas the percentages of internal organs, skin, bone, and total water were highest. The remaining piglets were grown up at *ad libitum* feeding. Differences in daily gains paralleled the differences in birth weights ($P=0.07$). At day 182 of age 58 pigs were randomly selected for slaughter. They were assigned to one of three birth weight classes (25% low; 50% middle; 25% heavy). The pigs of low birth weight had lower live weights ($P<0.05$), smaller meat percentages ($P=0.09$) and loin areas ($P=0.08$) compared to pigs of high birth weight, whereas the percentage of internal adipose tissue tended to be higher ($P=0.11$). In addition, pigs of low birth weight exhibited lower relative heart weights ($P=0.02$) and a higher drip loss ($P=0.08$) in *Longissimus* muscle (LD). The pigs of low birth weight exhibited the lowest muscle fiber numbers, the largest fiber size, the highest myonuclear number per fiber, and the highest percentages of abnormal giant fibers in ST and LD muscles ($P<0.05$). The results suggest that the deficiency in muscle fibers by genetic or maternal reasons in low birth weight piglets cannot be equalized by accelerated fibre hypertrophy and that in these pigs extremely large fibers may be one of the reasons for poor carcass quality at slaughter.

Key Words: Growth, Body Composition, Intrauterine Growth Retardation

399 Nutrition of Wagyu- and Piedmontese-sired fetuses alters newborn *longissimus* muscle cellular characteristics. P. L. Greenwood^{1,2}, H. Hearnshaw^{1,4}, G. Kelly^{1,3}, and D. W. Hennessy^{1,4}, ¹CRC for Cattle and Beef Quality, Armidale, NSW, Australia, ²NSW Agriculture, Armidale, NSW, Australia, ³University of New England, Armidale, NSW, Australia, ⁴NSW Agriculture, Grafton, NSW, Australia.

Longissimus lumborum muscle was studied in low and high birth weight Wagyu- (mean \pm SEM birth weights 27.3 ± 1.1 kg, $n=8$ [WL] vs 33.4 ± 1.4 kg, $n=8$ [WH]) and Piedmontese-sired (27.4 ± 1.9 , $n=7$ [PL] vs 40.2 ± 1.5 kg, $n=8$ [PH]) female calves following low or high nutrition of their Hereford dams during pregnancy. Muscle weight was greater ($P<0.05$) in Piedmontese-sired and high birth weight newborns (WL, WH, PL, PH means; pooled SE: 84, 101, 91, 150; 7g, respectively). Number of satellite cells relative to myofibre-related nuclei (6.7, 8.8, 8.3, 9.1; 0.8%) and myofibres (29.9, 36.8, 35.6, 41.8; 3.6 per 1,000 myofibres) tended ($P<0.10$) to be greater in high birth weight calves. Mass of muscle DNA (53.9, 52.5, 63.5, 78.8; 4.1 mg), RNA (229, 259, 267, 390; 26 mg) and protein (13.0, 16.1, 14.0, 23.7; 1.4 g) were greater in Piedmontese-sired calves, and mass of protein was greater in high birth weight calves who also tended to have more RNA. Apparent number of myofibres (29.8, 29.8, 32.2, 30.4; 2.5×10^5 myofibres) did not differ ($P>0.10$) due to genotype or prenatal nutrition. Percentage of type 1 myofibres was higher in Wagyu-sired and high birth weight calves (19.5, 25.0, 14.9, 21.6; 1.6%), and percentage type 2A myofibres (28.5, 23.1, 27.8, 23.9; 2.1%) and the ratio of fast to slow myofibres (4.4, 3.0, 6.9, 3.9; 0.8) increased with lower prenatal nutrition and tended to be greater in Piedmontese-sired calves. Cross-sectional area of type 2B myofibres was reduced by low birth weight (666, 751, 679, 910; $74 \mu\text{m}^2$) which also tended to influence average cross-sectional area of myofibres (507, 573, 505, 668; $56 \mu\text{m}^2$). The results demonstrate that maternal nutrition and low birth weight can impact on size, contractile and metabolic properties of myofibres in newborn cattle and may affect relative numbers of myosatellite cells. It remains to be established whether nutritionally altered cellular characteristics in muscle of newborn heifers with high muscle growth (Piedmontese-sired) or high marbling (Wagyu-sired) potentially have long-term consequences for growth, body composition and eating quality.

Key Words: Cattle, Nutrition, Muscle

400 High energetic costs of stereotyped behaviour in preruminant calves. J. J. G. C. van den Borne*, S. J. F. M. van der Heijden, H. Oorsprong, E. A. M. Bokkers, J. E. Bolhuis, and W. J. J. Gerrits, *Animal Sciences Group, Wageningen University and Research Centre, Wageningen, The Netherlands.*

High energetic costs for standing versus lying ($130 \text{ kJ/kg}^{0.75}/\text{d}$) in preruminant calves were mentioned in several experiments. Behaviour, and particularly stereotyped behaviour, can be an important reason for these high estimations. It was hypothesized that calves spend a considerable part of their time on stereotyped behaviour and that energetic costs of

stereotyped behaviour are high. In this study (originally not designed to study behaviour) energy expenditure related to stereotyped behaviour was quantified in individually housed preruminant calves. Eighteen preruminant calves (on average 120 kg BW) were used, in two experimental periods of 9 days each. Heat production was measured by indirect calorimetry in 6-min intervals. Physical activity was recorded by a radar-Doppler device and posture was recorded by infrared beam interruption. Energy expenditure related to activity was estimated. Behavioural observations were made of each calf for two days per period, 13 hours per day, using 6-min scan-sampling. Five and 47% of the time spent standing and lying, respectively, was spent idling. Main activities during standing were manipulating bucket (37%) and (other) objects (24%), and tongue playing (10%). Main activities during lying were tongue playing (15%) and self-licking (8%). The sum of these repetitive activities, except self-licking, was considered total stereotyped behaviour. Stereotyped behaviour during standing increased energy expenditure almost threefold ($+74 \text{ kJ/kg}^{0.75}/\text{d}$) compared to standing idle ($39 \text{ kJ/kg}^{0.75}/\text{d}$), while tongue playing during lying was energetically more expensive ($+25 \text{ kJ/kg}^{0.75}/\text{d}$) than lying idle ($1 \text{ kJ/kg}^{0.75}/\text{d}$). It can be concluded, that energetic costs for stereotyped behaviour are considerable, and account for up to 8 (lying) and up to 15% (standing) of the energy expenditure for maintenance. As stereotyped behaviour is more frequently shown in standing as opposed to lying calves, this affects estimation of posture-related energy expenditure.

Key Words: Calves, Behaviour, Energy Expenditure

401 Relationships between serum constituents at weaning and subsequent carcass characteristics of beef calves. J. May¹, M. Looper², C. Golden¹, M. Nihsen¹, K. May³, and C. Rosenkrans Jr.*¹, ¹Department of Animal Science, University of Arkansas, Fayetteville, ²USDA-ARS, Dale Bumpers Small Farms Research Center, Booneville, AR, ³Caldwell Farms, Rosebud, AR.

Fall born Brangus-crossbred calves ($n = 112$; BW = 224 ± 12 kg) were used to determine the relationship between serum constituents at weaning and carcass characteristics. At weaning, calves were weighed, blood samples collected, and bull calves castrated two days later. After the stocker phase (145 d), calves were weighed and then finished in a commercial feedlot. Serum samples were analyzed for lactate dehydrogenase (LDH) activities, hemoglobin, protein, creatinine, prolactin, triiodothyronine (T_3), thyroxine, cortisol, testosterone, and insulin-like growth factor-I (IGF-I). After harvest, *longissimus* muscle and ribfat thickness were measured. In addition, USDA quality and yield grades were assigned to each carcass. A retrospective ANOVA was conducted with quality grade, yield grade, and calf gender in the model as independent variables and serum constituents as dependent variables. At harvest, 65% of the carcasses were assigned USDA Choice grade. Carcass distributions among USDA yield grade were 22, 48, and 29%, respectively for yield grade 1, 2, and 3. Heifers had higher ($P < 0.05$) concentrations of cortisol and T_3 than bulls at weaning (32 vs 20 ng/mL cortisol; 4.0 vs 3.5 ng/mL T_3), and less ($P < 0.001$) testosterone (0.5 vs 3.2 ng/mL). Serum LDH activity, when corrected for hemoglobin concentration, was lower ($P < 0.05$) in calves that ultimately graded USDA Choice when compared with animals that resulted in USDA Select carcasses. Serum concentrations of IGF-I and cortisol at weaning were associated with an interaction ($P < 0.1$) of quality grade and yield grade. Yield grade was associated ($P < 0.1$) with weaning LDH activity, and testosterone concentrations. These data support previous studies indicating that serum LDH activity could be used as an early indicator of a calf's probability to grade USDA Choice or better.

Key Words: Cattle, Lactate Dehydrogenase

402 Physiological indicators of growth are influenced by supplementation and steroid implantation in steers. M. L. Looper*¹, C. F. Rosenkrans, Jr.², R. Flores², G. E. Aiken³, and S. E. Duke⁴, ¹USDA-ARS, Dale Bumpers Small Farms Research Center, Booneville, AR, ²University of Arkansas, Fayetteville, ³USDA-ARS, Forage-Animal Production Research Unit, Lexington, KY, ⁴USDA-SPA, College Station, TX.

Forty-five crossbred steers (BW = 246 ± 5.4 kg) were utilized to determine the effects of timing of steroid implantation and supplementation on average daily gain, prolactin, triiodothyronine (T_3), thyroxine (T_4), cortisol, and insulin-like growth factor-I (IGF-I). All steers grazed bermudagrass paddocks (1 steer/0.8 ha). Each steer received either no

supplementation (n = 30) or 1.4 kg/d per steer of a corn-soybean meal supplement (n = 15; 12% crude protein). Within supplementation strategy, steers were assigned to either no implant, one implant at d 0 and one implant at d 56 (EI), or one implant at d 56 (LI). Steers were weighed at the initiation and termination of experiment to determine average daily gain (ADG). Blood samples were collected on d 0, 62, and 108, and blood metabolites were quantified. Supplemented steers had greater (P < 0.0001) ADG than non-supplemented steers (0.93 ± 0.05 vs 0.57 ± 0.04 kg/d, respectively). Implanted steers (EI and LI) tended to have increased (P = 0.13) ADG compared with non-implanted steers. Concentrations of prolactin and T₄ were decreased (implant x time; P < 0.05) in control and LI (one steroid implant) steers but not EI (two steroid implants) steers at 108 d compared to d-62 concentrations. Cortisol was influenced by a supplement x implant interaction (P < 0.05). Supplemented EI steers had increased cortisol compared to supplemented LI steers (58.8 ± 10.0 vs 35.3 ± 9.2 ng/mL for EI and LI steers, respectively). However, non-supplemented LI steers had increased concentrations of cortisol compared with non-supplemented EI steers (56.8 ± 6.6 vs 42.2 ± 6.4 ng/mL for LI and EI steers, respectively). Supplemented steers, independent of timing of implantation, had increased (P < 0.001) concentrations of IGF-I compared with non-supplemented steers (211.5 ± 19.9 vs 122.7 ± 11.8 ng/mL, respectively). Concentrations of T₄ at d-0 were positively correlated (P < 0.05; r = 0.33) with ADG of steers. Management strategies may alter animal physiology, and those strategies should be considered when using physiological markers for the prediction or selection of animal growth.

Key Words: Steers, Thyroxine, Insulin-like Growth Factor-I

403 A mechanistic nutrition model to evaluate beef cow efficiency. L. O. Tedeschi¹*, D. G. Fox¹, M. J. Baker¹, and K. L. Long², ¹Cornell University, Ithaca, NY, ²Bell Ranch, Solano, NM.

The beef cattle seedstock industry is searching for ways to select for improved beef cow efficiency. Most selection indexes for efficiency have a

Nonruminant Nutrition: Minerals

404 Mineral and chromium supplementation to diets of finishing pigs. B. V. Lawrence*, D. Overend, S. A. Hansen, J. D. Hahn, and J. Hedges, Hubbard Feeds Inc., Mankato, MN.

A total of 765 terminal Duroc cross barrows and gilts (Compart Boar Store Line 442 X D100; 29.8 ± 1.2 kg) were used to compare three treatments: corn-soybean meal control (CTRL), CTRL diet for 63 d with Yield Pak (a blend of vitamins and trace minerals) added from 63 to 91 d (CTRL/YPC), or CTRL/YPC diet supplemented with 200 ppb Cr from chromium propionate from d 0 to 63 (Cr/YPC). Pigs (12 pens/treatment) were weighed on d 0, 63 and 91. Growth performance was similar across treatments (P > 0.10) from d 0 - 63. Day 63 to 91 gain (P < 0.05) and gain:feed (P < 0.01) were lower for the CTRL pigs. At 111.6 ± 7.3 kg, 36 gilts per treatment were tagged, tattooed, and weighed. After 8 h transit to a commercial abattoir, hot carcass weights (HCW) were obtained (84.3 ± 1.8 kg). The HCW and yield [(HCW/liveweight)*100] were different (P < 0.01) between treatments. Fat or muscle depth, lean percentage, and ham and loin pH measured at 1 and 22 h post-mortem were not different (P > 0.10) across treatments. At 22 h, a 40 - 50 g loin core was taken between the 7th and 8th ribs and held for 7 d for drip loss determination. Although there was no difference in 22-h pH or rate of 22-h pH decline, the Cr/YPC pigs had a higher (P < 0.10) drip loss than other treatments (4.78 vs. 3.43%). The NPPC measures of loin color, and firmness, as well as ColorTec L*, A*, and B* values were not different (P > 0.10) across treatments. Loin marbling was higher (P < 0.05) for the CTRL/YPC pigs than for the CTRL or Cr/YPC pigs (2.80 vs. 2.46). Forty gilts per treatment (live weight of 115.6 ± 6.1 kg) fed the CTRL or CTRL/YPC diet at the commercial finisher were processed as described previously. There was a trend (P < 0.10) for the CTRL/YPC pigs to have a higher yield (75.5 vs. 74.9%). The higher yield corresponded with a trend (P < 0.10) toward a reduction in loin drip loss (4.03 vs. 5.30%) and a numerical (P < 0.20) reduction in rate of 22-h ham pH decline (0.55 vs. 0.67 units). These results indicate that addition of YPC in late finishing may improve some meat quality characteristics of fresh pork.

Key Words: Minerals, Pigs, Meat Quality

goal of using less resource while obtaining the same outcome in a sustainable environment. However, the inputs required to determine individual beef cow feed efficiency are not readily available in practical conditions. A mathematical model was developed to use inputs readily available in each production situation to estimate the ratio of cow ME required to calf-weaning weight (WW) for computing an energy efficiency index (EEI). This model ranks EEI estimates and compares individual cow EEI with the range of expected EEI using Monte Carlo (MC) methods to identify the upper and lower cutoff values. It uses the 2000 Beef NRC recommendations as implemented in the Cornell Net Carbohydrate and Protein System for energy requirements for maintenance, lactation, and pregnancy. Data containing varying levels of milk and forage intake of individual calves during the first 200 d after birth was used to develop a submodel to estimate calf forage and peak milk intake (PKM) based on calf BW and forage composition. A database collected from the Bell Ranch, NM (N = 182) was used to evaluate the ranking from most to least efficient cows. The simulation indicated that as peak milk (PKM) increases, WW increases almost linearly, the difference in the calf WW between small and large cows tended to increase, and EEI estimates improve exponentially. As PKM increased, the EEI difference between small- and large-size cows decreased. The model-predicted least efficient cows were in agreement with culling decisions made prior to evaluating the EEI ranking. The MC simulation based on the distribution, mean, and variability of cow BW, PKM, and forage quality indicated that cows having EEI lower than 30.6 or higher than 38 Mcal/kg are within the 10% more and less efficient cows, respectively. Our analysis suggested this model could assist beef producers in identifying the most and least efficient cows for their resource, and can be used to simulate different production scenarios to identify the best match of cow type to alternative management systems.

Key Words: Modeling, Simulation, Production

405 Performance effects of potassium and chloride levels in swine finisher diets. B. V. Lawrence*, J. D. Hahn, and S. A. Hansen, Hubbard Feeds Inc., Mankato, MN.

Two trials with terminal cross Duroc sired pigs were conducted to evaluate the effect of K or Cl levels in corn-soya-synthetic amino acid diets on growth and carcass parameters. In Exp 1, 512 pigs (38.7 ± 1.1 kg) were assigned to either a Control diet (0.22% Na, 0.41% Cl, and 0.73% K), or the Control diet supplemented with 0.10% (Low), 0.20% (Med), or 0.30% (High) K supplied as KCl. Constant Na and Cl levels were maintained by altering the level of dietary NaCl and NaPO₄. Pens (n = 6) were weighed on d-0, 21, 42, 63, and 85. In Exp 2, 512 pigs (32.9 ± 0.8 kg) were fed one of four diets. The Control diet was similar to that in Exp 1. The remaining 3 treatments were formulated to 0.94% K and 0.22% Na and either 0.60% (High Cl), 0.47% (Med Cl) or 0.33% (Low Cl) chloride. The Cl levels were achieved by altering inclusion level of NaPO₄ and NaCl. Pens (n = 6) were weighed on d-0, 21, 42, 63, 85 and 96. At the end of both experiments, real-time ultrasound (RTU) measurements of tenth rib loineye area (LEA) and backfat (TRF) as well as last rib fat (LRF) were obtained on 40 barrows and 40 gilts per treatment. Yield, fat depth, loin depth, and lean percentage were obtained on 40 barrows and 40 gilts per treatment at a commercial abattoir. Data was analyzed using the GLM procedures of SAS with pen the experimental unit for gain, intake and feed conversion and individual pig the experimental unit for RTU and abattoir analysis. During Exp. 1, pigs fed the K supplemented diets had numerically higher gains, however, there were no significant (P>0.10) differences in gain, intake, or feed conversion. K supplementation had no influence on RTU or abattoir carcass parameters. In Exp. 2, pigs fed the Med Cl diets tended to have the highest (P<0.10) gain. There was no diet effect (P>0.10) on intake or feed conversion. RTU and abattoir carcass measurements were not different (P>0.10) across treatments. Yield was lowest (P<0.05) for the Low Cl fed pigs. These results suggest that K supplementation may improve growth, while the appropriate Cl level may influence gain and yield.

Key Words: Electrolytes, Growth, Pigs

406 Comparisons of inorganic and organic trace mineral supplementation for grow-finish swine. J. L. Burkett^{*1}, K. J. Stalder¹, C. R. Schwab¹, T. J. Baas¹, D. W. Newcom¹, J. L. Pierce², W. J. Powers¹, and J. W. Mabry¹, ¹Dept. of Animal Science, Iowa State University, Ames, ²Alltech Inc., Nicholasville, KY.

A study was conducted to investigate the effect of inorganic and organic mineral supplementation on the growth and ultrasonically measured carcass characteristics of swine. In each of the two replications, 264 pigs were used in a completely randomized design with four dietary treatments and 10 - 12 pigs per pen (n = 24) throughout the grow-finish period. A commercial line of barrows and gilts were penned by sex, and randomly assigned to one of the four treatments at approximately 27 kg. Treatment 1 (control) contained a common trace mineral supplement (Kent Feeds, Muscatine, IA), while treatments 2, 3, and 4 contained Alltech's Bioplex products at 100%, 75%, and 50% of the common trace mineral supplemental levels, respectively. Individual tenth rib backfat (BF) and loin muscle area (LMA) measurements were evaluated ultrasonically on all pigs prior to marketing (118 kg). Average daily gain and average daily lean growth on test (LGOT) were calculated from the data collected on individuals. Pen feed intake was calculated by feed weigh-back to determine ADFI, feed efficiency (FE), and efficiency of lean gain (LE). Pen was the experimental unit of measurement in this study. Data from this study were analyzed using a mixed linear model with fixed effects of replication, treatment, and sex and the interaction of sex by treatment. Pen nested within treatment was included as a random effect for the evaluation. Off test weight was included as a covariate for the analyses of BF and LMA. On test weight was included as a covariate in the analyses of ADG, LGOT, ADFI, FE, and LE. Replication and sex effects were significant sources of variation for BF, LMA, ADG, LGOT, and ADFI. Pigs fed the control diet consumed less (P < 0.05) feed per day than pigs fed the three experimental diets. This study revealed no differences (P > 0.05) among the treatment means for BF, LMA, ADG, LGOT, and LE.

Key Words: Pigs, Mineral Supplementation, Ultrasound Measurements

407 The effects of high phytase levels on nutrient digestibility, growth performance and bone characteristics in growing pigs. M. J. Azain^{*1} and M. R. Bedford², ¹University of Georgia, Athens, ²Zymetrics, Golden Valley, MN.

Phytase is typically supplemented at less than 1000 U/kg diet. The objective of this study was to look at the effects of higher levels of phytase supplementation in the growing pig. A total of 144 pigs (initial wt = 13 kg) were randomly assigned to one of six dietary treatments with 3 barrows or 3 gilts per pen and a total of 48 pens in 2 trials. A corn-soy diet (20% CP, 1.12% lysine) was used. Diet 1 was the positive control and contained 0.90% Ca and calculated total and available P of 0.55 and 0.28%, respectively. Diets 2-6 had less dicalcium phosphate added and contained 0.70% Ca and 0.40 and 0.13% total and available P. Diet 2 was the negative control and diets 3-6 were supplemented with 100-12,500 U/kg feed of a novel *E. coli* Phytase expressed in *Pichia pastoris*. Diets were fed for 28 d. Apparent nutrient digestibility was determined using chromic oxide as a marker during the last week of the trial. Pigs were euthanized and metatarsal bone isolated for determination of bone strength and mineral content. Pigs fed the P deficient diet had reduced growth and efficiency as well as decreased bone weight and strength. Phytase addition improved growth rate and bone parameters. Ca and P digestibility were improved with phytase, but there was no significant effect on protein or energy digestibility. Bone Ca and P content were not affected by dietary treatment. However, bone Mg was decreased and K increased on the P deficient diet. Both were normalized with the addition of phytase to the diet. Pigs fed diets with 12,500 U Phytase/kg had growth rates, nutrient digestibilities and bone characteristics that were superior to the pigs fed the positive control diet. This effect may be accounted for by the removal of the anti-nutritional effects of phytate.

	Diet:				Phytase, U/kg		SEM	P
	Pos Ctrl	Neg Ctrl	100	500	2500	12500		
Gain, g/d	629	465	530	549	634	712	14	0.001
G:F, g/kg	571	492	527	548	580	613	16	0.001
Digestibility, %								
CP	77.3	77.9	74.9	76.9	77.4	78.5	1.5	NS
Energy	81.9	82.8	81.3	81.1	83.0	83.1	1.0	NS
Ca	63.6	51.3	55.9	56.5	70.9	78.9	1.9	0.001
P	40.8	21.3	20.7	28.4	58.9	75.5	2.4	0.001
Bone								
Weight, g	6.28	5.23	5.52	5.85	6.51	7.10	0.21	0.001
Ash, %	34.4	28.8	28.6	30.6	34.0	37.9	0.7	0.001
Strength, kg	52.09	31.94	35.01	41.47	53.29	68.047	2.30	0.001

Key Words: Swine, Phytase, Bone Ash

408 Shifting the pH profile of *Aspergillus niger* PhyA phytase improves its efficacy in pig diets. S. U. Rice, T. G. Ko, T. W. Kim, K. R. Roneker, and X. G. Lei^{*}, Cornell University, Ithaca, NY.

Aspergillus niger PhyA phytase is widely used in swine diets, but its pH optimum (5.5) is too high for an effective hydrolysis of phytate-P under the acidic condition in the pig stomach. Using site-directed mutagenesis, we have developed two mutants (TK10 and TK228) with lower pH optima than the wild-type (WT) of PhyA. The objective of this experiment was to compare the effectiveness of TK10 and TK224 with that of WT in improving dietary phytate-P availability to pigs. A total of 24 weanling pigs (8.41 ± 0.49 kg BW) were divided into three groups (n = 8), and fed a low-P, corn-soybean meal basal diet supplemented with the WT, TK10, or TK228 phytases at 250 units/kg of feed for five weeks. Growth performance, plasma inorganic P concentration, and plasma alkaline phosphatase activity of individual pigs were recorded or measured weekly. The overall daily gain of pigs fed the TK228 mutant phytase was 13% higher (509 vs 451 g, P < 0.05) than that of those fed the WT enzyme. Pigs fed TK228 also had higher (P < 0.05) plasma inorganic P concentrations at weeks 2-5, but lower (P < 0.05) plasma alkaline phosphatase activity at weeks 3-5 than those fed the WT enzyme. Feeding pigs with the TK10 mutant enzyme resulted in growth performance or plasma measures similar to those fed the WT enzyme. In conclusion, the shift of pH optimum in the TK228 mutant PhyA phytase enhanced its efficacy in the corn-soybean meal diets for weanling pigs. However, the similar shift in the TK10 mutant rendered no benefit over the WT enzyme.

Key Words: Phytase, Pigs, Phosphorus

409 Phosphorus excretion of pigs fed conventional or low-phytate corn-soybean meal diets without or with phytase. E. G. Xavier, L. A. Pettey, G. L. Cromwell^{*}, and M. D. Lindemann, University of Kentucky, Lexington.

Two 5-d balance experiments were conducted to assess diets containing normal (N) corn and N soybean meal (SBM) or low-phytate (LP) corn and LP, low-oligosaccharide SBM without or with phytase (Natuphos[®], BASF; 750 units/kg) on total and soluble P excretion in pigs. The LP-corn and LP-SBM were provided by Pioneer Hi-Bred International. The N-corn, LP-corn, N-SBM and LP-SBM contained 0.32, 0.26, 0.66, and 0.77% total P and 0.06, 0.17, 0.21, and 0.55% non-phytate P with estimated P bioavailabilities of 20, 75, 25, and 50%, respectively. Twelve pigs (52 kg) in metabolism crates were fed four diets (0.90% lysine) during two periods. Feeding level was equalized within replications and averaged 96% of ad libitum intake. Diets were (1) N-corn + N-SBM, 0.57% P; (2) N-corn + N-SBM + phytase, 0.47% P; (3) LP-corn + LP-SBM, 0.39% P; and (4) LP-corn + LP-SBM + phytase, 0.35% P. Diet 4 contained no added inorganic P. Ca was reduced from 0.58% in Diets 1 and 3 to 0.53% in Diets 2 and 4. All diets had the same levels of non-phytate P (0.28%) and bioavailable P (0.27%), assuming that phytase released one-third of the unavailable P. Daily feed and P intake averaged 1.91, 1.92, 1.96, 1.96 kg/d and 9.95, 8.05, 7.65, 6.88 g/d for Diets 1 to 4, respectively. Apparent P digestibility was increased by feeding the LP- vs N-diets and by phytase addition (37, 56, 66, 78%; P < 0.05). Total P in feces and urine was 3.09, 1.89, 1.58, 0.95% of DM (P < 0.05) and 21, 29, 36, 48 mg/L. Daily P excretion in feces, urine, and both

were affected by diet (6.24, 3.58, 2.62, 1.51 g/d, $P < 0.05$; 0.07, 0.13, 0.19, 0.20 g/d; 6.31, 3.71, 2.81, 1.71 g/d, $P < 0.05$), as were absorbed P (3.71, 4.46, 5.03, 5.36 g/d; $P < 0.05$) and retained P (3.63, 4.34, 4.84, 5.16 g/d; $P < 0.05$). Total P excretion decreased by 41% when phytase was added to the N-diet, by 55% when the LP-diet was fed, and by 73% when phytase was included in the LP-diet. Soluble P in excreta, expressed as % of total P, increased ($P < 0.05$) with the LP-diet and with phytase (2.0, 4.4, 7.1, 12.8%), but daily soluble P excretion was not affected ($P > 0.50$) by diet (0.13, 0.17, 0.23, 0.23 g/d).

Key Words: Pigs, Phosphorus, Phytase

410 Estimation of Ca and P retention in bone, fat-free soft tissue, and other whole body and carcass components in growing-finishing pigs from 18 to 109 kg. L. A. Pettey*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington*.

The distribution of Ca and P in carcass bone, carcass fat-free soft tissue (FFST), and viscera (empty)-head-blood-skin (VHBS) was determined in 50 pigs from 18 to 109 kg BW to develop equations describing the retention rates of Ca and P. Ca and P in hair and hooves was inconsequential. Data were combined from two studies in which pigs were killed at 18, 27, 36, 45, 54, 73, 91, and 109 kg. Pigs were fed fortified corn-soy diets (four phases) that exceeded NRC standards for lysine, Ca, and P by 0.1%. Carcasses were split with the right half physically separated into soft tissue, bone, and skin. Chemical analysis was conducted on each body tissue. Carcass bone represented 10.0, 9.5, 9.0, 8.2, 8.3, 8.1, 7.4, and 7.5% of BW for the eight weight groups, respectively. Bone Ca represented 98.8% of the Ca in the carcass and was constant from 18 to 109 kg BW. Carcass P contributed by bone was constant from 18 to 54 kg (71.9%), but increased linearly ($P < 0.01$) to 75.1% from 54 to 109 kg BW. In fresh bone, protein, lipid, ash, Ca, and P concentrations increased linearly ($P < 0.01$) with increasing BW, while water concentration decreased linearly ($P < 0.01$). Ca and P concentrations in fresh bone were 4.2, 4.8, 5.2, 5.9, 5.7, 6.6, 6.9, and 7.4%; and 2.3, 2.5, 2.8, 3.1, 3.1, 3.3, 3.6, and 3.7%, respectively. In bone ash, Ca and P averaged 33.8 and 17.7% across all BW groups. FFST was constant (45% of BW) across BW groups. Ca and P concentrations in FFST were unchanged with BW and averaged 0.012 and 0.210%, respectively. Based on days from 18 to 36, 36 to 54, 54 to 73, 73 to 91, and 91 to 109 kg BW, the retention rates of Ca and P were calculated for bone, FFST, and VHBS. The predicted Ca retention rates for 27, 45, 64, 82, and 100 kg pigs (means of the five BW ranges) were 4.03, 5.68, 6.71, 7.03, and 6.70 g/d ($Y = 0.34 + 0.1635X - 0.001X^2$), and predicted P retention rates were 3.06, 4.16, 4.79, 4.88, and 4.47 g/d ($Y = 0.49 + 0.1158X - 0.00076X^2$). When combined with Ca and P needs for maintenance, a net requirement for Ca and P can be estimated for pigs from 20 to 110 kg BW with this model.

Key Words: Pigs, Bone, Phosphorus

411 Endogenous excretion of phosphorus and calcium in growing pigs fed two varieties of soybean meal. R. N. Dilger* and O. Adeola, *Purdue University, West Lafayette, IN*.

Using the regression approach, whole body endogenous excretion of phosphorus and calcium were measured in growing pigs fed diets containing conventional or high available phosphorus (HAP) soybean meals (SBM) as the primary phosphorus and calcium source. Semipurified cornstarch-based diets contained four graded levels of each soybean meal; thereby creating a linear dietary intake of phosphorus (0.7, 1.3, 2.0 and 2.7 g/kg DM) and calcium (0.5, 0.9, 1.4 and 1.8 g/kg DM). Chromic oxide (3.0 g/kg diet, as-fed) was used as an indigestible index and pigs were fed at a rate of $0.09 \times BW^{0.75}$ kg according to individual weekly BW. Sixteen barrows (average initial BW of 17.7 kg) were fitted with simple T-cannula at the distal ileum and fed the diets according to a replicated 8 X 8 Latin square design. Experimental periods were 7 d in length with 5 d diet acclimation, sampling of feces on d 5 and 12-h collection of ileal digesta on each of d 6 and 7. Apparent pre-cecal phosphorus and calcium digestibilities exhibited a linear relationship to dietary mineral intake for conventional ($P < 0.01$) but not HAP SBM ($P > 0.10$). Conversely, apparent total tract phosphorus and calcium digestibilities increased linearly to dietary mineral intake for HAP ($P < 0.02$) but not conventional SBM ($P > 0.10$). Endogenous outputs

of phosphorus in ileal digesta were different between SBM sources ($P < 0.01$; 7.9 vs. 4.2 g/kg DMI for conventional and HAP SBM, respectively) but not when determined in the feces ($P > 0.10$; 0.02 vs. 0.09 g/kg DMI for conventional and HAP SBM, respectively). True pre-cecal and total tract digestibilities of phosphorus and calcium were higher for HAP SBM compared with conventional SBM ($P < 0.01$). This was due in part to the 34- and 47-fold reductions ($P < 0.01$) in endogenous phosphorus output (DMI basis) between the ileal and fecal collection sites for conventional and HAP SBM, respectively. These data suggest the regression approach may be used to estimate whole body endogenous mineral output though an inherently high degree of variability seems to exist with this methodology.

Key Words: Endogenous, Minerals, Pigs

412 A novel procedure for measuring endogenous phosphorus losses and true phosphorus digestibility by growing pigs. G. I. Petersen* and H. H. Stein, *South Dakota State University, Brookings*.

A novel procedure was developed to estimate endogenous losses of phosphorus by growing pigs. A P-free diet was formulated using mainly cornstarch, dextrose, gelatin, and crystalline AA. In Exp. 1, two P-free diets were formulated using gelatin of either porcine or bovine origin. The apparent (AID) and standardized (SID) ileal digestibility coefficients of AA in these two diets were compared to the AID and SID in soybean meal (SBM). Results of this experiment showed that there were no differences in AID or SID for any of the indispensable AA except for trp between the three feed ingredients when fed to growing pigs. In Exp. 2, a P-free diet based on gelatin of porcine origin was used to measure the apparent (ATTD) and true (TTTD) total tract digestibility of three sources of inorganic phosphorus. In addition to the P-free diet, three other diets were formulated based on the P-diet, but each of these diets were supplemented with either monosodium phosphate (MSP), purified monocalcium phosphate (MCP) or dicalcium phosphate (DCP). The inorganic phosphate sources were added to the P-free diet to reach a total P-content in the diets of 0.2%. Each of the four diets was fed to 7 pigs for 12 d. Fecal material was collected for five d using the marker to marker procedure. Results of the experiment showed that the ATTD in DCP was lower ($P \leq 0.05$) than in MCP (81.49 vs. 91.88%), while the ATTD in MCP (87.96%) was similar to the other two sources. The endogenous losses of P were calculated based on the P-concentration in the fecal samples from pigs fed the P-free diet and averaged 0.139 g P per kg DMI. By correcting the ATTD for the endogenous losses, the TTTD were calculated. For DCP, MCP, and MSP, the TTTD was 88.41, 94.93, and 98.20%, respectively. The value for MSP was higher ($P \leq 0.05$) than the value for DCP, while the TTTD for MCP was not different from the other two sources. The two experiments showed that the P-free diet provides a way of estimating endogenous losses of P in pigs and can be used to calculate ATTD and TTTD in feed phosphates.

Key Words: Endogenous Loss of P, P-Free Diet, True Digestibility of P

413 Evaluation of the bioavailability of phosphorus in distillers dried grains with solubles (DDGS) when fed to pigs. R. W. Fent*¹, T. S. Torrance², B. W. Ratliff¹, S. X. Fu¹, G. L. Allee¹, D. M. Weibel², and J. D. Spencer², ¹*University of Missouri, Columbia*, ²*United Feeds, Inc., Sheridan, IN*.

A slope ratio assay was conducted to estimate the bioavailability of phosphorus (P) in distillers dried grains with solubles (DDGS). Seventy-two barrows (initial wt = 15.0 kg) were individually penned and allotted by weight to one of nine dietary treatments in a randomized complete block design. All diets were cornstarch-soybean meal based. Treatments 1-7 comprised the slope ratio assay consisting of a basal diet (0.25% P, 1.25% TID Lys) and diets containing 0.075, 0.150, and 0.225% additional P from either monosodium phosphate (MSP) or DDGS. The two additional diets consisted of the 0.225% P DDGS + 500 FTU/kg phytase (Optiphos#8482; Phytex, LLC) and the basal diet + 500 FTU/kg to assess the possible further liberation of phosphorus. Pigs were allowed ad libitum access to feed and water. After a 28-d feeding period, all pigs were weighed, sacrificed, and right fibulas collected for analysis of bone breaking load and bone ash content. The standard curve (MSP) and the DDGS titration both resulted in linear improvements ($P < 0.01$) in ADG, ADFI, gain:feed, fibula breaking load, and fibula bone ash content. The bioavailability estimate of the phosphorus contained in DDGS was estimated as the ratio of the slopes of the DDGS

curve to the standard curve. The resulting P bioavailability estimates for DDGS relative to MSP were 84.3% and 85.3% for fibula breaking load and fibula bone ash, respectively. The basal diet + 500 FTU/kg phytase resulted in greater fibula breaking load (18.7 vs 13.7 kg force) and bone ash (1.049 vs 0.896 g) as compared with the basal diet, resulting in calculated P release of 0.082 and 0.064%, respectively. The 0.225% P DDGS + 500 FTU/kg phytase also resulted in greater fibula breaking load (31.9 vs 24.6 kg force) and bone ash (1.681 vs 1.389 g)

as compared with the 0.225% P DDGS diet. Taking into consideration the response from soybean meal, phytase supplementation resulted in complete P bioavailability from DDGS. These results indicate that the bioavailability of phosphorus in DDGS is approximately 85% with the remaining phosphorus liberated with additional phytase.

Key Words: Distiller's Dried Grain, Phosphorus, Pigs

Physiology and Endocrinology: Strategies for Appointment Breeding of Beef and Dairy Cattle

414 Comparison of EAZI-BREED CIDR inserts with melengestrol acetate in progestin-based protocols to synchronize estrus in beef cows. D. J. Schafer*, J. F. Bader, D. C. Busch, F. N. Kojima, M. R. Ellersieck, M. C. Lucy, M. F. Smith, and D. J. Patterson, *University of Missouri, Columbia.*

Follicular dynamics and timing of estrus and ovulation were compared in 48 nonsuckled, estrous cycling beef cows using EAZI-BREED CIDR inserts (CIDR) or melengestrol acetate (MGA) in progestin-based protocols to synchronize estrus. Cows were assigned equally (n=12) to one of four treatments (T1 to T4) by age and body condition. Cows in T1 were fed MGA (0.5mg·hd⁻¹·d⁻¹) for 14 d, GnRH (100 µg Cystorelin) was injected on d 26, and PGF_{2α} (PG; 25 mg Lutalyse) on d 33. Cows in T2 had CIDRs (1.38g progesterone) inserted for 14 d, GnRH was injected on d 23, and PG on d 30. Cows in T3 were fed MGA for 7 d, injected with PG on d 7, GnRH on d 11, and PG on d 18. Cows in T4 had CIDRs inserted for 7 d, were injected with PG on d 7, GnRH on d 9, and PG on d 16. Transrectal ultrasonography was performed daily to monitor follicular dynamics from GnRH to estrus after PG; and every 4 h from 20 h after the onset of estrus until ovulation was confirmed. Estrus detection was performed with HeatWatch. Emergence of a new follicular wave after GnRH, and estrus after PG did not differ (P>.10) among treatments: T1, 11/12; T2, 9/12; T3, 11/12; T4, 9/12. Mean interval to estrus (h) was shorter (P<.05) for cows in T3 and T4 than cows in T1 and T2 (T1, 62 ± 2.1; T2, 59 ± 2.4; T3, 51 ± 2.1; T4, 52 ± 2.4). Follicle diameter (mm) at GnRH did not differ (P>.10) among treatments; differed at PG (P<.05) between T2 and all other treatments (T1, 12.2 ± .5; T2, 10.7 ± .5; T3, 13.0 ± .5; T4, 12.9 ± .5); and differed (P<.05) 20 h after the onset of estrus between T1 and T2. Progesterone (ng/mL) at PG was greater (P<.001) for cows in T1 and T2 than T3 and T4 (T1, 3.7 ± .4; T2, 3.9 ± .4; T3, 1.8 ± .4; T4, 1.7 ± .4). Interval from estrus to ovulation (h) was shorter (P<.05) for cows in T4 than T3 (T1, 30 ± 1.2; T2, 30 ± 1.4; T3, 31 ± 1.2; T4, 27 ± 1.4). These data demonstrate the flexibility in using MGA or CIDR inserts in progestin-based protocols to synchronize estrus in beef cows. (Supported by USDA-NRI grant 2000-02163).

Key Words: Progestin, Beef Cows, Estrus Synchronization

415 Substituting EAZI-BREED CIDR inserts (CIDR) for melengestrol acetate (MGA) in the MGA Select protocol in beef heifers. F. N. Kojima*, J. F. Bader¹, J. E. Stegner¹, D. J. Schafer¹, J. C. Clement², R. L. Eakins¹, M. F. Smith¹, and D. J. Patterson¹, ¹University of Missouri, Columbia, ²Cow Calf Research and Consulting, Mandan, ND.

This study was designed to compare estrous response, timing of AI and pregnancy rate resulting from AI among beef heifers that were presynchronized with MGA or the CIDR insert prior to GnRH and PGF_{2α} (PG). Heifers (n = 353) at three locations (location 1, n = 154; 2, n = 113; and 3, n = 85) were assigned randomly to one of two treatments by age and weight. The MGA Select-treated heifers (MGA; n = 175) were fed MGA (0.5 mg·hd⁻¹·d⁻¹) for 14 d, GnRH (100 µg i.m. Cystorelin) was injected 12 d after MGA withdrawal, and PG (25 mg i.m. Lutalyse) was administered 7 d after GnRH. CIDRs (CIDR; n = 177) were inserted in heifers for 14 d, GnRH was injected 9 d after CIDR removal, and PG was administered 7 d after GnRH. CIDR-treated heifers received carrier without MGA on days that coincided with MGA feeding. Heifers were monitored for signs of behavioral estrus beginning the day PG was administered. AI was performed 12 h after onset of estrus and recorded as day of AI (Day 0 = PG). Pregnancy rate to AI was determined by ultrasonography 40 d after AI. Quantitative data were analyzed by ANOVA and qualitative data were compared by Chi-square analysis. Distribution of AI was analyzed by ratio of variance (F-test) for mean interval to AI. No interactions between locations and treatments were detected;

therefore, data were pooled for analyses. Estrous response did not differ (P > 0.10) between treatments. Peak AI occurred on Day 3 for heifers in both treatments (CIDR 122/177, 69%; MGA 93/175, 53%), and distribution of AI was more highly synchronized (P < 0.05) among CIDR- than MGA-treated heifers. Pregnancy rate to AI was greater (P < 0.01) in CIDR- (112/177, 63%) than MGA-treated heifers (83/175, 47%), however, final pregnancy rate did not differ (P > 0.10) between treatments. In summary, replacing feeding of MGA with CIDR inserts improved synchrony of estrus and pregnancy rate resulting from AI in replacement beef heifers.

Key Words: Beef Heifers, Estrus Synchronization, Progestin

416 MGA and CIDR based timed AI protocols in postpartum beef cows. D. Kreider*, N. Post, R. Rorie, T. Lester, and E. French, *University of Arkansas, Fayetteville.*

An experiment was conducted to compare two timed AI, estrus synchronization protocols in postpartum beef cows. Straight bred Angus cows (n = 125) in herds 1 (n = 54) and 2 (n=71) were sorted by BW and body condition score (BCS); then randomly assigned to treatments. Treatments were: MPGG: MGA (.5mg/hd/d) for 14 d followed by 25mg Lutalyse (PG) 17 d after MGA withdrawal and GnRH (100 µg Fertagyl) 48 h after PG; and CIDR: 100 µg GnRH plus Eazi-Breed CIDR for 7 d, then PG followed in 48 h by GnRH. All cows were inseminated 18 h after GnRH, and then placed with a fertile bull at 10 d after AI. Conception rate (CR) was determined by ultrasound at 30 d post AI and pregnancy rate (PR) was determined by palpation 55 d after bull removal. Serum was collected and analyzed for progesterone (P4) on d -6, 1 and 31 of MGA treatment for MPGG and on d -6, 1 and 7 for CIDR. Cows were assumed to be cycling if P4 was ≥ 1 ng/ml on d -6 or 1 and were considered to have a functional CL if P4 was ≥ 1 ng/ml on d 31 (MPGG) or d 7 (CIDR). BW and BCS, d postpartum at the start of treatment and CR to AI were all different between herds (P < 0.01), but treatments did not differ in initial BW, initial BCS and days postpartum, either within herd (P > 0.14) or for the combined data (P > 0.10). Percent of cows cycling at the start of treatments differed (P = 0.001) between herds (35% vs 92% for herds 1 and 2 respectively), and between MPGG and CIDR in herd 1 (18% vs 54%, respectively; P = 0.006). Conception rate to AI was 25% in MPGG vs 46% in CIDR in herd 1 (P = 0.09) and overall pregnancy rate was 79% in MPGG vs 69% in CIDR (P = 0.86). In herd 2, percent cycling at the start of treatment, and conception rate to AI did not differ between MPGG and CIDR (89% vs 94%, P = 0.35; and 53% vs 65%, P = 0.19; respectively). For the combined data, percent cycling at the start of treatment and conception rate to AI differed between MPGG and CIDR (58% vs 76%, P = 0.03; and 57% vs 41%, respectively, P = 0.04). Under the conditions observed in this study, conception rates to timed AI using an MGA based protocol tend to be lower than those obtained with a CIDR based protocol in postpartum beef cows.

Key Words: Timed AI, Estrus Synchronization, Beef Cows

417 Effect of timing of insemination and estrous synchronization method on AI pregnancy rates in beef heifers. B. R. Dorsey*, J. B. Hall, W. D. Whittier, and W. S. Swecker, *Virginia Polytechnic Institute and State University, Blacksburg.*

The objectives of this experiment were to evaluate time of insemination relative to estrus and synchronization with melengestrol acetate with PG (MGA-PG) or an intervaginal progesterone insert with PG (CIDR-PG) on AI pregnancy rate in beef heifers. Crossbred heifers were blocked by weight and assigned to MGA-PG (n = 176) or CIDR (n = 173). The MGA-PG group received MGA (0.5 mg/hd/d for 14 d) followed by PG (25 mg Lutalyse, Pfizer) 19 d after last feeding of MGA. The CIDRs

were inserted for seven days and PG administered 1 d before CIDR removal. Heifers were fitted with HeatWatch (HW) transmitters (n = 200) or heat detection aid (K-mar). Estrus was monitored by HW or thrice daily visual estrous detection. Heifers detected in estrus (n = 270) were randomly bred AI (EAI) once daily beginning at 0900. Heifers not detected in estrus by 96 h after PG (n = 79) were bred by fixed-time AI (TAI) and received GnRH (100 µg Cystorelin, Meriel) at TAI. Pregnancy status was determined via ultrasonography at 60d post AI. Overall AI, EAI and TAI pregnancy rates were analyzed by Chi Square using CAT-MOD procedures of SAS. A majority of heifers (77.4%) were bred AI following estrus. Estrous synchronization method did not (P > 0.5) affect overall, EAI or TAI pregnancy rates. Pregnancy rates for MGA-PG versus CIDR-PG heifers were 53.4% vs. 54.9%; 59.9% vs. 63.3%; 26.5% vs. 31.1% for overall AI, EAI, and TAI, respectively. Data were pooled across estrous synchronization method to determine effect of timing of AI relative to estrus (n = 247). Heifers were grouped by 4 h periods relative to first estrual mount. Time of AI relative to estrus did not (P = 0.30) affect EAI pregnancy rate. Pregnancy rates for heifers bred AI at 0-4, 4-8, 8-12, 12-16, 16-20, 20-24, and > 24 h after estrus were 62.5%, 56.7%, 79.3%, 63.2%, 53.8%, 65.7%, 60.6%, respectively. We conclude that MGA-PG and CIDR-PG are equally effective for synchronizing beef heifers, and that time from estrus to AI, up to 24h, did not affect AI pregnancy rate.

Key Words: Heifers, Estrous Synchronization, AI

418 Factorial analysis of timed AI (TAI) protocols for synchronization of first and second insemination in dairy cattle. J. P. Meyer*, R. P. Radcliff, M. L. Rhoads, J. F. Bader, C. N. Murphy, and M. C. Lucy, *University of Missouri, Columbia.*

The PGPG TAI protocol uses a series of prostaglandin F_{2α} (PGF) and GnRH injections to synchronize ovulation for TAI. We examined the utility of the first PGF and GnRH injections within PGPG by testing a factorial treatment arrangement within a single study conducted on a large commercial dairy. The PGPG cows were treated with PGF (25 mg Lutalyse), 3 d, GnRH (100 µg Cystorelin), 8 d, PGF, 2 d, GnRH and TAI (n=131). Other treatments were PPG (PGF, 11 d, PGF, 2 d, GnRH and TAI; n=149), GPG (GnRH, 8 d, PGF, 2 d, GnRH and TAI; n=158), PG (PGF, 2 d, GnRH and TAI; n=160) and Ovsynch (GnRH, 7 d, PGF, 2 d, GnRH and TAI; positive control; n=138). The TAI were done within 6 h of the last GnRH. The efficacy of the first PGF injection and the first GnRH injection could be estimated by comparing PGPG/PPG with GPG/PG and by comparing PGPG/GPG with PPG/PG, respectively. Pregnancy was determined by ultrasonography on days 28 and 42 after TAI. The 28 d pregnancy rate (26.0, 31.8, 32.8, 29.3, and 40.3%), 42 d pregnancy rate (22.1, 24.8, 27.2, 23.8, and 32.6%), and embryonic loss rate (28 to 42 d; 15.6, 15.9, 18.8, 18.2, and 20.0%) were similar for PGPG, PPG, GPG, PG, and Ovsynch, respectively. There was no effect of the first PGF or the first GnRH on pregnancy rate. Cows were randomly assigned to receive either GnRH or control (no injection) on d 22 after TAI. Cows diagnosed nonpregnant on d 28 were then treated with PGF on d 29, GnRH on d 31 and TAI. The random pretreatment with GnRH on d 22 enabled a test of two resynchronization TAI protocols [Ovsynch (GnRH, 7 d, PGF, 2 d, GnRH and TAI) versus PG (PGF, 2 d, GnRH and TAI)]. The percentage of cows with corpora lutea on d 28 (pregnancy exam before resynchronization) and the 42 d pregnancy rate following resynchronization were similar for Ovsynch [131/154 (85.1%) and 38/154 [24.6%]] and PG [132/163 (81.0%) and 39/163 (23.9%)]. We conclude that a simple TAI protocol (PGF, 2 d, GnRH and TAI; Rapid synchronization) may be an effective method for TAI in large commercial dairies.

Key Words: Dairy, Cow, AI

419 Effects of CIDR inserts on first service pregnancy rates of lactating dairy cows submitted to a presynch program and on re-synchronization of second service in Mexico. F. Moreira*, R. Flores, J. Boucher, and J. Chenault, *Pfizer Animal Health.*

Objectives were to evaluate if EAZI-BREED CIDR Cattle Inserts (CIDR) increase first service pregnancy rate (FSP) of a Presynch program and if CIDR would affect second service estrus detection (EDR) and pregnancy rates (PR). The single-site study was conducted in Central Mexico. Within barns (n=3), parity, and week of enrolment, cows

were assigned to either Presynch or Presynch-CIDR for their first service. Presynch was initiated at 25±3 days postpartum with 25 mg of PGF_{2α} (5 mL, i.m.; LUTALYSE Sterile Solution) and a second PGF_{2α} 14 days later. At 14 days later, cows received 100 µg of GnRH (2 mL, i.m.; CYSTORELIN), PGF_{2α} 7 days later, GnRH 48 hours later, and timed insemination (TI) 12 to 20 hours later. Presynch-CIDR cows also received a CIDR Insert (1.38 g of progesterone) which was administered at first GnRH and removed 7 days later. Presynch and Presynch-CIDR cows were assigned to receive a CIDR insert at 14 days after first service for a 7-day period (Resynch) or no additional treatments (Control). Resynch cows were observed for estrus and inseminated between days 22 and 26 after TI. Control cows were observed for estrus and inseminated between days 4 and 26 after TI. Thus, there were 4 treatments: Presynch/Control (n=415), Presynch/Resynch (n=406), Presynch-CIDR/Control (n=414), and Presynch-CIDR/Resynch (n=403). Cows were palpated for pregnancy 45 to 60 days after insemination. Presynch-CIDR cows had increased PR compared to Presynch (43% and 37%, respectively; P=0.021). EDR did not differ between Resynch and Control (51% and 51%, respectively). In primiparous cows, PR was decreased for Resynch compared to Control (18% and 26%, respectively; P=0.045). In multiparous cows from the Presynch-CIDR group, PR was increased for Resynch compared to Control (21% and 11%, respectively; P=0.034). CIDR increased FSP of lactating cows submitted to Presynch. Resynch had no effect on EDR, negative effects on PR of primiparous cows, but positive effects on PR of multiparous cows.

Key Words: CIDR, Presynch, Re-Synchronization

420 Resynchronization of ovulation in Holsteins after not pregnant diagnosis. J. S. Stevenson* and S. M. Tiffany, *Department of Animal Sciences, Kansas State University, Manhattan.*

We compared outcomes of 2 protocols used to resynchronize estrus and ovulation in not pregnant females. Nulliparous heifers and lactating cows in which AI occurred 41 ± 0.7 d (range: 26 to 200 [91% between d 27 and 53]) earlier were presented every 2 to 3 wk for pregnancy diagnosis using ultrasonography. Ovaries were scanned, follicles mapped and sized, presence of corpus luteum noted, and 100 mcg of GnRH injected. Seven days later, 25 mg of PGF was injected and females were assigned randomly to receive a second GnRH injection 48 h (Ovsynch; n = 224) or 1 mg of estradiol cypionate (ECP) 24 h after PGF (Heatsynch; n = 230). Those detected in estrus since diagnosis were inseminated, whereas the remainder received a timed AI (TAI) between 65 and 74 h after PGF. Based on ovarian scans and blood collected before injections for progesterone analysis, 4 groups were classified: anestrus; cystic; cycling, and unknown. Few females (n = 23; 5.1%) were detected in estrus between pregnancy diagnosis and through the day of ECP injection. On the day following ECP injection through the day of TAI, more (P<0.01) ECP- than GnRH-treated females were inseminated based on estrus (33 vs. 13%). Overall, more (P<0.01) Ovsynch than Heatsynch females were TAI (82 vs. 62%). Pregnancy rates were greater (P<0.01) for females inseminated after estrus (34%) than after TAI (24%), but differences were greater between estrus and TAI for Heatsynch (38 vs. 21%) than Ovsynch (33 vs. 27%) females. Pregnancy rates for groups were: anestrus (9%; n = 23); follicular cysts (25%; n = 12); luteal cysts (33%; n = 12); unknown (25%; n = 63); and cycling (28%; n = 344). Pregnancy rates did not differ among parities, but tended (interaction: P = 0.12) to differ between Heatsynch and Ovsynch within parity, respectively: heifers (50% [n = 20] vs. 30% [n = 20]); first lactation (27% [n = 108] vs. 22% [n = 92]), and 2+ lactations (23% [n = 102] vs. 30% [n = 112]). We conclude that little difference occurred in pregnancy outcomes after either the Ovsynch and Heatsynch protocols when applied to dairy females after a not pregnant diagnosis.

Key Words: Ovsynch, Heatsynch, Resynchronization

421 Variations in the Ovsynch protocol after presynchronization of estrous cycles alter pregnancy rates in lactating dairy cows. M. A. Portaluppi* and J. S. Stevenson, *Department of Animal Science, Kansas State University, Manhattan.*

Our objectives were to determine pregnancy rates after altering times of the second GnRH injection and AI in the Ovsynch protocol to accommodate AI once daily while cows were locked up at the feed bunk. Cows (n = 654) from 2 dairy herds in northeastern Kansas were studied. Cows ranged from 24 to 44 DIM at the start of the Presynch protocol

consisting of two injections of PGF 14 d apart with the second given 12 d before initiating treatments. Cows were blocked by lactation number and assigned randomly to 3 treatments consisting of variations of the Ovsynch protocol. Cows in Cosynch-48 and Ovsynch received injections of GnRH 7 d before and 48 h after a PGF injection. Fixed-time inseminations (TAI) were made at the time of the second GnRH injection (0 h; Cosynch-48) or 24 h (Ovsynch). Those in Cosynch-72 received the second GnRH injection at 72 h after PGF and were inseminated at the same time. Pregnancy was diagnosed by palpation on d 40 or 41 after TAI. Pregnancy rates in both herds were consistently greater ($P < 0.05$) for Cosynch-72 than for Cosynch-48 and Cosynch-72 vs. Cosynch-48 + Ovsynch. First-lactation cows ($n = 263$) had greater ($P < 0.05$) pregnancy rates (32 vs. 27%) than older cows ($n = 391$). The BCS at TAI ranged from 1.0 to 4.0. Cows having BCS #8805 2.25 ($n = 469$) had greater ($P < 0.05$) pregnancy rates than those having BCS < 2.25 ($n = 185$): 31% vs. 24%, respectively. For each 10-d increase in DIM at the first Presynch PGF injection, pregnancy rates increased ($P < 0.05$) by $9 \pm 4\%$. We concluded that pregnancy rates for cows in which estrous cycles were presynchronized before the Cosynch-72 protocol were greater than those treated with the Cosynch-48 and Ovsynch protocols. Table 1. Pregnancy Rates at 40-41 Days after First Insemination

Herd	Cosynch-48	Ovsynch	Cosynch-72	Total
1	17 (78)	19 (78)	25 (72)	20 (228)
2	27 (139)	34 (134)	41 (143)	34* (426)
Total	23 (217)	29 (212)	35** (215)	29 (654)

* Different ($P < 0.01$) from herd 1.

** Different ($P < 0.05$) from Cosynch-48 and Ovsynch.

Key Words: Pregnancy Rates, Presynchronization, Ovsynch

422 The effect of deep intrauterine placement of semen on conception rate in dairy cows. M. G. Diskin^{*1}, J. R. Pursley², D. A. Kenny³, J. F. Mee⁴, and J. M. Sreenan¹, ¹Teagasc, Atheryn, Co. Galway, Ireland, ²Michigan State University, East Lansing, ³University College Dublin, Belfield, Dublin, Ireland, ⁴Teagasc, Fermoy, Co. Cork, Ireland.

The reported results of the effect of deep intra-uterine horn insemination on conception rate (CR) in cattle is equivocal. Some reports indicate an improvement while others report no improvement in CR. The objective of this study was to determine the effect of bi-lateral uterine horn artificial insemination (AI) on CR in dairy cows. This study was carried out over two years involving 6 commercial inseminators in each year, 4 of which were involved in both years. All inseminators were trained prior to the start of the experiment in each year. Each alternate cow presented for AI in co-operating herds was inseminated by placing all of the inseminate in the body of the uterus (Body) or by placing 50% of the inseminate beyond the curvature in each uterine horn (Horn). Data was collected on a total of 1860 inseminations in 37 herds in 2002 and on 1586 inseminations in 24 herds in 2003. Pregnancy diagnosis was performed using ultrasonography at 28 to 60 days post AI. Data were

analyzed using PROC CATMOD with terms for AI treatment, year, inseminator, and their interactions included in the model. There was no effect (>0.05) of AI treatment x inseminator x year, treatment x year or inseminator x year on CR. There was a significant effect ($P < 0.02$) of AI treatment x inseminator on CR, with evidence of either an increase (+11.4%; $P < 0.05$), decrease (-4 to -6%; $P < 0.05$) or no effect ($P > 0.05$) of Horn AI on CR for individual inseminators. A retrospective analysis of the data for all 61 herds showed that the improvement in CR following Horn insemination was most evident in herds with lowest CR following Body AI. This study indicates that the effect of uterine horn AI on CR is not uniform and is inseminator dependent and may be ameliorated by the inherent level of herd fertility. Further studies are required to investigate the technique x inseminator interaction before any general recommendation could be made.

Key Words: Semen, Placement, Conception

423 The association between ultrasound reproductive tract scoring and commonly used veterinary therapeutics with pregnancy rates in spring-calving Holstein-Friesian cows. F. Buckley*, J. F. Mee, and P. Dillon, Teagasc, Dairy Production Research Centre, Moorepark, Fermoy, Co. Cork, Ireland.

The objectives of this study were to investigate if ultrasound reproductive tract scores (URTS) recorded prior to first service reflected subsequent fertility performance, and to discern if commonly used veterinary therapeutic regimes (VTR) administered post ultrasound examination led to improved reproductive efficiency. In total, 6,477 URT scores were analysed from 5,734 Holstein-Friesian cows in 61 spring-calving herds over 2 yr (1999 and 2000). In brief: URTS 1 was assigned to cows with a normal uterus that had recommenced ovulation post partum. A cow with URTS 2 had almost completed involution, had a small volume of mixed echogenic fluid in the uterine lumen, and was ovulatory. Cows with URTS 3 had partially completed involution, had a moderate volume of mixed echogenic fluid in the uterine lumen, and were ovulatory. Cows with URTS 4 were anovulatory, had partially completed involution with a small or moderate volume of mixed echogenic fluid in the uterine lumen. URTS 5 was pyometra. Cows with URTS 6 had completed uterine involution but were anovulatory. A lower pregnancy rate to first service (PREG1) was observed with URTS 2 (51%), 3 (36%), 5 (17%) and 6 (46%) when compared to URTS 1 (57%) ($P < \text{or} = 0.01$). VTR resulted in a lower PREG1 with URTS 1 (-6%, $P = 0.054$) (predominantly a prostaglandin (PG) regime) and URTS 6 (-12%, $P < 0.05$) (predominantly progesterone supplementation), when compared to cows with the same URTS receiving no VTR. Intervention with URTS 2 (predominantly washout (WO) +/- a PG regime) and URTS 4 (predominantly progesterone supplementation and a WO) had no significant effect on PREG1. A positive response to VTR was observed with URTS 3 (+17%, $P < 0.05$) and URTS 5 (+25%, $P < 0.05$), (predominantly a WO +/- PG and an intensive hormonal regime including a WO, respectively). In conclusion, URTS recorded prior to first service did reflect subsequent reproductive performance. However, the level of routine VTR being administered in these herds was unjustified.

Key Words: Ultrasound, Score, Fertility

Production, Management and the Environment: Reproduction and Behavior

424 Minimum temperature and maximum humidity: Predictors for conception of crossbred Holstein cows in Thailand. V. Punyapornwithaya¹, K. Kreausukon^{*1}, S. Theepatimakorn², and W. Suriyasathaporn¹, ¹Clinic of Ruminant, Faculty of Veterinary Medicine, Chiangmai University, Chiang Mai Province, Thailand, ²Chiangmai AI Center, Department of Livestock, Chiang Mai Province, Thailand.

In general, weather influences reproductive performance in dairy cattle. The objective of this study was to determine the effects of temperature and humidity on conception rate in small holder crossbred Holstein dairy herds in the tropics. Data from primiparous and multiparous dairy cows from 513 herds in northern part of Thailand, during January 2001 to November 2002, were used. Monthly average weather data, includ-

ing minimum and maximum of both temperature and humidity, were collected from Thai Meteorological department. Data were analyzed by creating generalized estimating equation (GEE) using PROC GENMOD (SAS version 8). The final data included 8,096 observations from 3,425 cows. For univariate analysis, all weather data except for the maximum temperature factor were negatively related to the risk of conception ($P < 0.01$). The final model included minimum daily temperature ($P < 0.01$) and maximum daily humidity ($P = 0.09$). The increasing of either minimum temperature or maximum humidity caused decreasing conception occurrence. Based on monthly average weather data, we concluded that cows have the lowest conception rate during June to August in Thailand.

Key Words: Temperature and Humidity, Conception, Dairy Cows

425 Diameter of head of tail as a negative energy balance indicator in relation to reproductive performance in dairy cows. K. Kreausukon*, V. Punyapornwithaya, W. Posuya, and W. Suriyasathaporn, *Clinic of Ruminant, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai Province, Thailand.*

Body Condition Scoring has been used as a management tool for evaluating negative energy balance in dairy cows. However, the efficiency of the scoring is based on each practitioner. The objective of this study was to determine the use of diameter of head of tail (DHT) parameter in relation to body weight (BW), body condition score (BCS), and reproductive performance in dairy cows. Data from sixty-five crossbred Holstein-Friesian cows calving during July to November 2003 from 31 farms in Mae-On sub-district, Chiangmai province were used. The DHT were measured at the 1st coccygeal by using vernier calipers. Data of DHT, BW, and BCS were collected before and after parturition, and data on calving date and first insemination date were recorded for calculated day to first service. The maximum losses of DHT, BCS, and BW, were found at 6 weeks after parturition. Subsequently the data at 6 weeks was used and analyzed by Pearson Correlation Coefficients. Results showed that loss of DHT was positively related to loss of BCS, loss of BW, and day to first service ($P < 0.01$). In conclusion, measuring DHT before and after parturition can be used as a management tool in dairy farms.

Key Words: Diameter of Head of Tail, Day to First Service, Dairy Cows

426 Can acceptable pregnancy rates be achieved using exclusive timed artificial insemination for first service? M. B. Capel*¹, D. V. Nydam², and R. Saltman³, ¹*Perry Veterinary Clinic*, ²*NYS College of Veterinary Medicine*, ³*Pfizer Animal Health.*

The goal of this study was to determine if acceptable pregnancy rates can be achieved using exclusive timed artificial insemination for first service. The study was conducted on a commercial dairy milking 1,900 cows. Rolling herd average, heat detection rate, and pregnancy rate (defined as the proportion of cows open and eligible for breeding that become pregnant per 21-day period) were 11,200 kg, 67%, and 20% for the previous year, respectively. The breeding program for the past two years was a prostaglandin (PGF₂α) injection at 30-36 days in milk (DIM) and 14 days later (Pre-Synch). All cows not bred by natural heat detection after a 46 day voluntary waiting period (vwp) were given GnRH at 57-63 DIM, PGF₂ α 7 days later, GnRH 2 days later, and bred 12-16 hours later (Ov-Synch). This program served as the control group for the trial. The treatment program was a Pre-Synch, Ov-Synch program with no natural heat detection on first service that started at 9-15 DIM. The treatment group also had a 46 day vwp, and 100% of the treatment group cows were bred by 52 DIM. All cows present on the farm at 9-15 DIM were enrolled in the study. Cows in both groups found open at pregnancy examination were placed on Ov-Synch either the same day if a corpus luteum was detected by rectal palpation, or in one week if one was not detected. The sample size for the study was 1049 cows. Pregnancy rates for both groups presented in the following table indicate that it is biologically possible to achieve high pregnancy rates using exclusive timed artificial insemination for first service beginning at 46 DIM.

DIM	Treatment Group	95% Confidence Interval	Control Group	95% Confidence Interval
	Pregnancy Rate		Pregnancy Rate	
46-66	30	25.9-34.5	20	16.7-23.1
67-87	18	14.1-21.5	28	24.2-32.3
88-108	25	20.6-30.2	21	16.4-25.5
109-129	21	15.5-27.4	23	17.6-29.5
Total	25	22.1-27.2	23	20.5-25.4

Key Words: OvSynch, Pregnancy Rate, Breeding

427 System for in vitro production with sexed sperm in commercial dairy herds. R. D. Wilson*¹, K. A. Weigel¹, P. M. Fricke¹, M. L. Leibfried-Rutledge², D. L. Matthews¹, V. R. Schutzkus¹, and J. J. Rutledge^{1,2}, ¹*University of Wisconsin, Madison*, ²*BOMED Inc., Madison, WI.*

Our objective was to research a system exploiting the synergy among ovulation (estrus) control, sexed sperm and in vitro production for replacement heifers production on commercial farms. Holstein cull cows (n=104) were selected by herd owners for use as donors, and ovaries were collected via colpotomy or at slaughter. Oocytes (n=4542) were aspirated from the ovaries and used to produce embryos in vitro using sex-sorted sperm from 3 Holstein sires. Seven Wisconsin herds participated and 365 embryos were produced (3.5 ± 0.4 transferable embryos per donor) although only 272 embryos were transferred (fresh) due to limited availability of recipients. Embryos were transferred into recipients 6, 7, or 8 d after recipients either expressed estrus or ovulation occurred (i.e. Ovsynch synchronization). Recipients cows that showed standing estrus had a conception rate of 16.3 %, while those resulting from a synchronization program had a mean conception rate of 20.0%. Recipient heifers (all in standing estrus) had conception rate of 34.2%. Conception rates for female in vitro produced embryos were lower ($P < 0.005$) than timed artificial insemination in cows and heifers (24.3% and 36.1% respectively). For the last 124 embryo transfers, GnRH (100μg, IM) was randomly administered recipients immediately after embryo transfer. Farm, GnRH, embryo sire, and season had significant effects on conception rate. To date 28 full term calves have been born; 89% were female. Mean lifetime net merit of donor cows was $\$122 \pm 17$, while that of recipients was $\$130 \pm 13$. Therefore, additional replacement heifers can be produced using selected cull cows as donors, with little or no adverse effect on genetic merit of the herd. These results suggest that in vitro production has promise as an early system for utilizing sexed semen in dairy cattle breeding programs. However models of implementation should continually be investigated, a working model will be beneficial to the dairy industry.

Key Words: Sex-Sorted Sperm, In Vitro Production, Holstein Cattle

428 Effect of clinical mastitis and other diseases on reproductive performance of Holstein cows. F. Frago¹, A. Ahmadzadeh*¹, B. Shafii¹, J. C. Dalton², M. A. McGuire¹, and W. J. Price¹, ¹*University of Idaho, Moscow*, ²*University of Idaho, Caldwell Research & Extension Center, Caldwell.*

This study investigated the effect of clinical mastitis and its interaction with other diseases on reproductive performance of lactating Holstein cattle. Data were collected from cows that calved between June 2001 and October 2003. Retrospectively, cows (n=963) were divided into four groups: clinical mastitis with other diseases (group 1), clinical mastitis only (group 2), other diseases only (group 3), and healthy cows (group 4). Days in milk at first service (DIMFS), services per conception (S/C), days open (DO), and proportion of cows that remained open by 220 DIM were analyzed. Groups 1 and 2 had higher ($P < 0.05$) S/C compared to group 4 (2.8 ± 0.4 and 2.1 ± 0.1 vs. 1.6 ± 0.1 , respectively). Moreover, groups 1 and 2 had higher ($P < 0.05$) DO compared to group 4 (155 ± 15 and 107 ± 5 vs. 88 ± 2 , respectively). Based on non-linear exponential decay model, the rate by which animals became pregnant over time was lower ($P < 0.05$) for groups 1, 2, and 3 compared to group 4. Moreover, the proportion of cows that remained open by 220 DIM was higher ($P < 0.05$) in groups 1, 2, and 3 compared to group 4. There was no difference in DIMFS among groups possibly due to programmed breeding. Mastitis affected ($P < 0.05$) S/C and DO only when clinical mastitis occurred after 105 DIM. Time of mastitis occurrence had no effect on DIMFS. Results suggest that reproductive efficiency was decreased by the presence of clinical mastitis in that a greater proportion of cows with mastitis remained non-pregnant over time. Furthermore, the negative effects were exacerbated when cows experienced both clinical mastitis and other diseases.

Key Words: Clinical Mastitis and Other Diseases, Reproductive Performance, Dairy Cow

429 Use of audible Doppler and B Mode ultrasonography to monitor fetal heart rate of hair sheep in the tropics. R. W. Godfrey*¹, L. Larsen¹, A. J. Weis¹, and S. T. Willard², ¹University of the Virgin Islands, Agricultural Experiment Station, Kingshill, VI, ²Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State.

There is little information available on the fetal development of hair sheep in a tropical environment. The objective of this study was to compare measurements of crown-rump length (CRL) and fetal heart rate (FHR) throughout gestation using B-mode and Doppler ultrasonography in hair sheep. St Croix White, Barbados Blackbelly and Dorper X St. Croix White ewes (n = 54) were bred to St Croix White, Dorper, Barbados Blackbelly and Dorper X St. Croix White rams. Fetal measurements were collected weekly starting 28 d after a successful mating. Linear array B-mode ultrasonography (5 and 7.5 mHz) was used to measure CRL and visual FHR and Doppler ultrasonography was used to measure audio FHR. Due to the size of the fetus CRL was not measurable after 42 d of gestation and visual FHR was not measurable after 70 d. Audio FHR was not consistently measurable before 35 d but could be measured through 140 d of gestation. There was no effect ($P > 0.10$) of breed of dam or sire on CRL or FHR. Single lambs had higher CRL ($P < 0.01$) than twin or triplet lambs at d 35 and 42 of gestation. There was no difference ($P > 0.10$) in visual or audio FHR between single, twin and triplet lambs. Visual FHR was higher ($P < 0.09$) than audio FHR at 28, 42 and 49 d of gestation. Audio FHR and days of gestation of singles, twins and triplets had a linear relationship ($y = 255.44 - 0.392(x)$, $r^2 = 0.15$). Crown-rump length and days of gestation of singles, twins and triplets had a linear relationship ($y = -3.43 + 0.17(x)$, $r^2 = 0.59$). The relationship between days of gestation and visual FHR of single, twin and triplet lambs was best described by a cubic equation ($y = -531.19 + 39.56(x) - 0.62(x^2) + 0.002(x^3)$, $r^2 = 0.37$). These results indicate that FHR can be monitored using Doppler ultrasonography for a longer period of time during gestation in hair sheep than either visual FHR or CRL measured by B-mode ultrasonography.

Key Words: Sheep, Ultrasound, Fetus

430 Effect of time of feed delivery on the feeding and lying behavior of lactating dairy cows. T. J. DeVries* and M. A. G. von Keyserlingk, *The University of British Columbia, Vancouver, BC, Canada.*

Feeding activity of group-housed dairy cows is highest during the day, with peak feeding times occurring in the morning and late afternoon immediately after milking and delivery of fresh feed. What is unclear is whether it is the return from milking or delivery of fresh feed that has the greatest effect on stimulating cows to feed. The objectives of this experiment were to determine: 1) which of these management practices has the greater ability to stimulate dairy cattle to go to the feed alley, and 2) the effect of moving the time of feed delivery away from milking on the feeding and lying behavior of dairy cows. These objectives were tested by separating feeding and milking times, and monitoring the changes in feeding and lying behavior of free stall housed cows. Forty-eight lactating Holstein cows were subjected to each of two treatments in a 2 x 2 cross-over design replicated over time. The treatments were: 1) milking and feeding time coinciding, and 2) feeding 6 h post milking. Cows were milked twice daily at 0500 h and 1700 h. Time-lapse video was used to quantify the lying time of the cows and an electronic feed alley monitoring system was used to monitor the feeding behavior of the cows. When animals were fed 6 h post milking, they increased ($P = 0.02$) their daily feeding time by 12.5%. This change was predominantly driven by a 26% decrease ($P = 0.006$) in the feeding time during the first hour post-milking and a 82% increase ($P = 0.007$) in feeding time during the 60 min following the delivery of fresh feed. Feeding 6 h post milking did not change the daily lying time of the cows ($P = 0.9$), however, cows that did not have fresh feed upon return from milking lay down 20 min sooner ($P < 0.001$) after the return from milking. These results indicate that the delivery of fresh feed has a greater impact on stimulating cows to go to the feed alley than does the return from milking. Additionally, these results indicate that feeding and lying behavior of dairy cows are affected by changes in feeding management.

Key Words: Feeding Time, Feeding Behavior, Dairy Cows

431 Impacts of grouping and space during gestation on body-condition and lesion scores and performance of sows. J. L. Salak-Johnson*, S. R. Neikamp, S. E. Curtis, and S. L. Rodriguez-Zas, *Department of Animal Sciences, University of Illinois, Urbana.*

Knowledge of impacts of grouping and floor space treatment during gestation on sow state-of-being and performance is limited. Objectives were to determine effects of individual (crate) vs group (pen) housing and optimal space allowance for grouped dry sows based on state-of-being and performance. At d27 of gestation, 5 sows per treatment were allocated to crate or group pen. Space in 3 pen treatments was 15, 25, or 35 ft²/sow, respectively. Sows in 6 replicates over 2 parities (n=120) were evaluated. Body condition (BCS) and lesions (LS) scores, health/injury, and lameness were assessed every 3 d the first 3 wk then weekly, thereafter. Productive performance was based on BW gain, backfat (BF) and farrowing data. Many significant treatment, day, parity, and interaction effects on performance occurred, but only treatment effects and linear and quadratic contrasts are reported. Overall, treatment affected BCS and LS ($P < 0.0001$); BCS was highest ($P < 0.0001$) in crated sows. Crated sows also had lower ($P < 0.0001$) LS regardless of body location. In grouped sows, there were many significant linear and quadratic contrasts. Grouped sows at 15 ft²/sow had higher ($P < 0.001$) LS at ears, head, neck, shoulder, back, rear, perineum-vulva, side than sows grouped at 25 or 35 ft²/sow that typically did not differ. Sows grouped at 35 ft²/sow had higher ($P < 0.001$) BCS than those at 15ft²/sow. Overall, treatment affected BW and BF ($P < 0.0001$); grouped sows at 25 and 35 ft²/sow were heavier and had deeper BF than other sows. Crated sows weaned fewer ($P < 0.02$) pigs than did grouped sows at 35 ft²/sow. There were no overall treatment effects on total pigs born and born alive, or various litter performance measures, but there were quadratic trends among pen treatments ($P = 0.05$). Sows at 25 ft²/sow had smaller litters, pigs of lower birth wt and fewer weaned than those at 35 ft²/sow. So, both grouping sows and space allowance during gestation influenced numerous measures of sow and litter performance.

Key Words: Sow, Gestation, Housing

432 Relationships between measures of temperament and carcass traits in feedlot steers. R. C. Vann*¹, J. C. Paschal², and R. D. Randel³, ¹MAFES-Brown Loam Experiment Station, Raymond, MS, ²TAMU-Cooperative Extension Service, Corpus Christi, TX, ³TAMU-Texas Agricultural Research and Extension Center, Overton, TX.

The objectives of this study were to evaluate effects of exit velocity (EV, m/s), chute temperament score (CS; 1=calm, no movement to 5=jumping and rearing; highly agitated) and pen temperament score (PS; 1=non-aggressive, not excited by humans to 5=aggressive, runs into fences and at humans if approached) and measure relationships between EV, CS and PS taken at two times near weaning (T1=21 d after weaning and T2=90 d later) with carcass traits and Warner-Bratzler shear force (WBS) values in feedlot steers. Crossbred steers (n=58) were assigned a PS, calves were weighed and assigned a CS, restrained in a cattle restraint chute then released and time recorded to travel 1.83 m. Sire consisted of one Brangus and several Angus sires. Least square means were obtained from PROC Mixed with main effects of sire breed, harvest date and age of dam. Sire breed was not a significant source of variation for EV, PS, CS, or carcass traits of longissimus muscle area (LMA), and back fat (BF); however, Brangus-sired steers had greater intramuscular fat (IMF; $P < 0.06$) at weaning and greater carcass longissimus muscle area per hundred weight (LMACWT; $P = 0.03$) and a higher USDA Yield grade ($P < 0.05$). The r between EV and PS at T2 was 0.61 ($P < 0.001$). The r between EV at T1 and WBS was 0.28 ($P < 0.03$) and EV at T2 and WBS was 0.34 ($P < 0.0095$). The r between EV and CS at T2 was 0.43 ($P < 0.008$). The r between PS at T1 and WBS was 0.24 ($P < 0.07$) and at T2 was 0.35 ($P < 0.008$). The regression coefficients between EV and WBS at T1 was 0.37 ($P < 0.04$) and at T2 was 0.57 ($P < 0.0095$) and PS and WBS at T1 was 0.39 ($P < 0.07$) and at T2 was 0.47 ($P < 0.008$). In conclusion, sire breed was not a significant source of variation in exit velocity. As exit velocity and pen score increased WBS values also increased.

Key Words: Feedlot Steers, Temperament, Carcass

433 Temperament alters adrenal response to exogenous ACTH in Brahman heifers. K. O. Curley, Jr.^{1,2}, D. A. Neuendorff², A. W. Lewis², J. J. Cleere², T. H. Welsh, Jr.¹, and R. D. Randel², ¹Texas Agricultural Experiment Station, College Station, ²Texas Agricultural Experiment Station, Overton.

The objective of this study was to compare adrenal responsiveness to stimulation with exogenous ACTH, in calm and temperamental heifers. Two-year old, spring born Brahman heifers comprised the two temperament groups that were selected using exit velocity (EV). The calm (C) and temperamental (T) groups consisted of the 6 slowest (EV=1.05±.05 m/sec) and 6 fastest (EV=3.14±0.22 m/sec) two-year old heifers within the herd. Blood samples were collected via indwelling jugular cannula for 6h pre- and 6h post- administration of ACTH (0.1 IU/kg BW). Sampling intervals were 15min throughout the 12h except for the final 180min; when the sampling intervals were 30min. Serum cortisol (CS) concentrations were determined via RIA. Pearson correlation coefficients and ANOVA were used for statistical comparisons. Basal CS, determined as the mean concentration (ng/mL) within the 1h period prior

to ACTH challenge, was correlated to EV (r=.87; P<.001) and differed (P<.001) between temperament groups (C=4.5±.7 and T=18.7±2.9). Following ACTH challenge, both peak CS and time to reach peak CS did not differ between temperament groups. Temperament influenced (P<.001) the increase, induced by the ACTH challenge, from basal CS (C=1375±215 and T=310±94%). A negative correlation was found between EV and % increase in CS (r=-.83; P<.001) increase. Time to return to basal CS was also influenced (P<.001) by temperament group as C took longer than T heifers (C=268±10 and T=154±18min). The area under the curve following the return to basal CS was not influenced by temperament (C=7548±644 and T=8464±428ng*min/mL), indicating that the CS concentrations in the temperamental heifers continued to decrease below basal concentrations. As poor temperament relates to increased basal adrenal activity and muted responsiveness to pharmacological stimulus, temperament does affect stress mechanisms. Exit velocity can be used as an indicator of temperament and predictor of adrenal response to ACTH.

Key Words: Temperament, ACTH Challenge, Exit Velocity

PSA - Environment and Management: Layer Management

434 The impact of layer dietary threonine levels on egg component yield, composition, and functionality. P. R. Niemeier*, C. D. Coufal, and J. B. Carey, Texas A&M University, College Station.

Over 20 weeks, one hundred 35 week old Single Comb White Leghorn laying hens were housed individually in an open sided laying facility with groups of 5 hens sharing access to a common feed trough. A typical layer diet (diet A) containing 0.56% threonine was fed to control hens. Four experimental diets containing additional levels of threonine were fed for 18 weeks. Diets B, C, D, E, contained threonine at levels of 0.66%, 0.76%, 0.86%, and 0.96% respectively. Egg samples were analyzed for egg weight, shell strength, and yolk and albumen yield, protein content, solids, and functionality. Albumen and yolk were kept separate and pooled by nutritional treatment, homogenized and analyzed for protein content and solids. Eggs were sampled at weeks 3, 10, and 16 for angel and sponge cake. Yolk and albumen were separated and pooled by nutritional treatment to make three replicates each of sponge and angel food cakes. Results were recorded by rapeseed displacement. Cake samples were cored, five cores per cake and subjected to double compression on the Instron Universal Testing machine. Cakes were measured for hardness, cohesiveness, springiness, gumminess, and chewiness. Yolk protein content was found to be significantly higher in diets C, D, and E, when compared to diets A and B. Yolk solids showed no significant differences over the dietary treatments. Sponge cake rapeseed displacement yielded no differences among diets. Albumen protein content was found to be significant higher in diets C and E when compared to the other diets. Diet E was found to have significantly higher albumen solids and angel cake rapeseed displacement when compared to the other dietary treatments. These data clearly indicate a potentially important impact of threonine nutrition of laying hens on LE yield, composition, and functionality.

Key Words: Threonine, Liquid Eggs, Egg Composition

435 Single and combined effects of yeast cell wall residue and Sel-Plex® on production and egg quality of laying hens. V. G. Stanley*¹, W. F. Krueger², and A. E. Sefton³, ¹Prairie View A&M University, Prairie View, ²Texas A&M University, College Station, ³Alltech, Guelph, ON, Canada.

The objectives of the study were to examine the effects of yeast cell wall residue (Bio-Mos) and Sel-Plex, single and combined on egg production and egg quality from 37-wk-old White Leghorn hens for 4 wk in a completely randomized designed experiment. Hens were reared in cages, 2 hens per cage, and fed the same corn-soybean based layer diet, supplemented with either Bio-Mos (2 kg/ton) or Sel-Plex (1 lb/kg) and combined with 16% CP, 2,800 kcal ME/kg, 3.5% Ca and .6% P. Hen-day egg production from the Sel-Plex-fed hens was significantly higher (P<.05) than the control (88 vs 81%) and Bio-Mos (83.2%). Egg production of the Bio-Mos plus Sel-Plex-fed hens was also significantly higher (90%) than the control (81.4%). Eggs from the Sel-Plex-fed hens weighed significantly more (68.13 g), had heavier yolks (31.9 g) and albumen (59.8 g), compared to the control [63.20%, 18.12 g (28.7%),

and 35.03 g (55.4%), respectively]. Sel-Plex plus Bio-Mos-fed hens produced yolk (20.68 g) and albumen (39.02 g) significantly heavier than control (18.12% and 35.51%, respectively). Eggs from the Bio-Mos-fed hens were significantly heavier than the control (65.41g vs 63.21g). However, yolk and albumen weights from the Bio-Mos-fed hens [19.42g (29.7%) and 35.91g(54.9%), respectively] did not differ significantly from the control [18.12g (28.7%) and 35.51g (56.2%), respectively]. Hens fed Bio-Mos supplemented-feed had significantly larger eggs (65.41g), yolk [19.38 g (29.6%)] and albumen weight [35.93g (54.93%)] compared to the control [63.14g, 18.07g (28.62%), 35.47g (56.18%), respectively]. Cholesterol concentration per gram of whole egg was significantly lower for the Sel-Plex-fed hens (193.2 mg/dL) compared to the control (236.1 mg/dL). Egg cholesterol concentration from the Bio-Mos plus Sel-Plex-fed hens was also significantly lower (211.2 mg/dL) than the control (236.1 mg/dL). The results suggested that Sel-Plex had beneficial effects on egg production, egg size, and egg cholesterol concentration and there appears to be a synergistic effect of Bio-Mos and Sel-Plex on egg production.

Key Words: Sel-Plex, Bio-Mos, Laying hens

436 Beak trimming of Leghorn pullets 2: Healing and beak re-growth. C. B. Annett*, K. Schwean-Lardner, and H. L. Classen, Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.

Beak trimming of White Leghorn pullets is performed in an attempt to reduce cannibalism and improve performance in the flock. This procedure, when optimally performed, removes the rostral portion of the beak, including the epidermis, innervated and vascularized dermis and bone of the maxilla and mandible. The objective of this study was to observe histological healing and neuroma formation and measure re-growth of beaks from two strains of pullets that had been beak trimmed at the hatchery, or trimmed on farm at 10d or 35d of age. Six beaks (2 trimmed of each strain and 1 each of untrimmed) were collected at 1d, 10d, 30d and 210d post trim and placed in 10% buffered formalin. Following fixation, beaks were trimmed sagittally and the medial aspect trimmed to 3-5 mm, mounted and stained with haematoxylin & eosin for histological examination. Healing was rated on a graded scale of 1 (no healing) to 7 (no lesions). At 2d, 86d and 43 wk of age, Vernier calipers were used to measure beak length from the rostral nares to the beak tip in 40 birds per treatment per strain. Data were analyzed as a 2 X 4 factorial analysis, with Duncans Multiple Range Test separating means when ANOVA was significant. No healing was seen in any of the treatment groups at 1d post trim. At 10d post-trim, beaks of pullets trimmed at the hatchery had a significantly improved healing score (4.25) compared to pullets that had been beak trimmed at 10d (1.25) and 35d (1.00) of age, however, by 30d post-trim healing between groups was not different (5.75, 5.50 and 5.00, respectively). Beaks were considered healed at 210d post-trim (6.00, 6.00, 6.00). Neuromas were not identified in any of the beaks examined. There were significant differences in beak length between all groups (untrimmed: 17.7 mm; 0d: 13.5 mm; 10d: 11.7; and 35d: 16.1mm) when measured at 43 wk of

age. In conclusion, there is faster healing and less re-growth of beaks when pullets are beak-trimmed at 0d or 10d of age compared to pullets beak-trimmed at 35d of age.

Key Words: Beak Trimming, Neuroma, Age

437 Ammonia emissions of commercial broilers from 0-42 days of age. L. Mitran*¹, J. Harter-Dennis¹, J. Meisinger², and J. Timmons¹, *Department of Agriculture and Natural Sciences, University of Maryland Eastern Shore, Princess Anne, ²USDA-ARS.*

An experiment was conducted to quantify the rate of ammonia (NH₃) emission from commercial broilers. This research is a part of a larger project to determine the total N budget of broilers. Six environmentally controlled chambers (37.2 m²) equipped with automatic feeding and watering systems were used. Pooled used wood shaving/sawdust litter was thoroughly mixed, weighed and equally distributed into the chambers. Five hundred one-day old birds (250 males, 250 females) were placed per chamber and raised for 42 days. Samples of litter, feed and birds were collected at the beginning, the end and at every feed change during the trial to determine the nitrogen content. A known percentage of the exhausted air was circulated through a weak acid solution to collect ammonia which was later determined using a QuikChem[®] 8000 Automated Ion Analyzer (QuikChem[®] Method 10-107-06-2-J). Ventilation rates were accurately estimated using an Alnor Electronic Balometer. Mean daily ammonia emissions ranged from 0.13 to 0.77g (NH₃-N)/b/d, with a mean of 0.36g NH₃-N/b/d and a coefficient of variation (CV) of 7.6%. Ammonia emissions were relatively constant (<.25 g/b/d) during the early growth period (0-17 days) followed by a linear increase from 18-42 days of age. The majority of NH₃-N(81%) was emitted from 18-42 days of age. This data may aid in the formulation of meaningful regulations and future research will also aid in the development of new management practices to reduce the emission of ammonia.

Key Words: Broilers, Nitrogen, Ammonia

438 Beak Trimming of Leghorn Pullets 3: Behaviour and welfare effects. K. Schwan-Lardner*, H. L. Classen, and C. B. Annett, *Department of Animal and Poultry Science, University of Saskatchewan.*

Beak trimming is controversial because of the beneficial reduction in cannibalism and the proposed detrimental pain associated with the procedure. The objective of this study was to determine if age at trimming had an effect on welfare as judged by behaviour or associated traits. White Leghorn pullets (2 strains - 480 each) were assigned to four treatments: untrimmed (C), hatchery trim (0d), or farm trimmed 10d or 35d of age. Pullets were housed in floor pens (40 per pen) to 17 wks of age. Behaviour was monitored (scan samples) at 0, 7, 14, 21 and 28d post trim (PT). At 16wk of age, tonic immobility was tested on 8 pullets per strain x treatment. Adult birds were housed in cages (6 replications of 15 birds per strain x treatment), and behaviour was monitored (focal birds) at 34 wk of age. Feather cover was scored at 58 wk of age. A 2 x 2 factorial analysis was used to analyze pullet behaviour data, and a 2 x 4 factorial analysis used for all other data. 0d birds pecked less at 1d PT, had fewer birds at the feeder 21d PT, and had more birds performing inactive standing 28d PT than C birds. Birds trimmed at 10d differed from C birds with more inactive standing (0, 7, and 21d PT), less time at the feeder (14, 21d PT), and less litter pecking (7, 14d PT). As compared to C birds, 35d trimmed birds were rested more (0d PT), spent more time inactive standing and less time feeding (0,7, 14d PT), with fewer birds at the drinkers and preening (0d PT). At 28d PT, C showed higher frequency of aggressive pecking compared to 35d. Adult birds behaved similarly. Pullets trimmed at 10d and 35d of age behaved differently for a longer period of time but did not show evidence of chronic pain. Tonic immobility comparisons (apriori contrasts) of 0d and 10d vs C showed longer latency to upright in C (P=0.09), suggesting a higher fear level. Feather cover was best on 0d and 10d and poorest on C. Trimming at 0, 10 or 35d caused no long term effect on welfare, but because of speed of beak healing and efficacy of trim, 0 and 10d may be preferable.

Key Words: Behaviour, Fear, Feather Cover

439 Effects of bill-trimming on the welfare of muscovy ducks. L. Gustafson*¹, H.-W. Cheng², E. Pajor², and J. Mench¹, ¹*University of California, Davis,* ²*Purdue University, West Lafayette, IN.*

Studies have shown that beak-trimmed chickens may show behavioral and physiological indicators of pain post-trim, but there is little information on the effects of bill-trimming on ducks. Muscovy ducks (N=96) were housed in mixed-sex pens containing 16 birds (8 per sex), with three replicate pens per treatment. One half of the birds were trimmed (TRIM) using secateurs at 20 days post-hatch, while the other half were untrimmed controls (CONT). The average length removed from the upper bill was .51cm, or 21.1% of the bill length from nares to tip. Two ducks/sex/treatment were randomly selected as focal birds for behavioral observations, which were conducted immediately post-trim and then at 3-day intervals. The frequency and duration of all behaviors was recorded using 15-min focal animal samples until age 68 days; all birds were weighed weekly. Two observation sessions/pen/week were conducted between 0900-1100 and 1200-1500. In the days immediately post-trim, CON ducks spent 33% of their time performing bill-related behaviors (preening, feeding, drinking, exploratory pecking), whereas TRIM ducks spent only 19% of their time performing such behaviors, a marginally significant difference (p=.063). This difference decreased by one week post-trim (CON 36.5%, TRIM 26.5%; p=0.14). There were no sex differences in behavior. By 4 days post-trim there were no significant (p=0.24) differences in weight between treatments; the average weights of CON and TRIM males were 900g and 640g, respectively, while those of CON and TRIM females were 760g and 720g. By 67 days, the lower bill of TRIM was on average only 11.9% longer than the top bill and there was also evidence of feather pecking, indicating substantial bill re-growth. Our behavioral data suggest that there is probably acute pain associated with trimming, but that it is not sufficiently severe to have marked effects on feed intake. The heads of the focal birds were collected during processing for morphological analysis of the bills. TRIM ducks had scar tissue near the beak stump; bills are currently being examined for evidence of neuromas, which are considered indicators of chronic pain.

Key Words: Bill-Trimming, Welfare

440 Effects of top-dressing recycled broiler litter on nitrogen mass balance. C. D. Coufal*, C. Chavez, P. L. Niemeyer, and J. B. Carey, *Texas A&M University, College Station.*

An experiment was conducted to access the effects of top-dressing recycled broiler on the nitrogen mass balance of a broiler grow-out facility. Six pens were used to rear five (flocks 10-14) consecutive flocks of broilers to 6 weeks of age. The bedding material in the pens was recycled rice hull broiler litter which had been used previously for 9 consecutive broiler flocks. Three pens received no litter treatment (control), while three pens were top-dressed (treated) with a thin layer (1-2 cm) of new rice hulls before each flock of birds was placed. A total of 840 broilers were used for each flock (420 bds/trmt.). Total nitrogen content of day-old chicks and all feeds was calculated as the total mass of nitrogen entering the facility. Nitrogen not accounted for from analysis of litter, caked litter, broiler carcasses and mortality was assumed to be lost from the facility (volatilized). Seasonal effects were observed regarding percent nitrogen loss from the facility when treatment was not considered. Nitrogen loss was significantly (P<0.05) higher in flocks 13 and 14 (warmer months), 26.0 and 35.5%, respectively, compared to flocks 10, 11 and 12 (cooler months), 16.7, 8.8 and 17.7%, respectively. Percent of total nitrogen partitioned into the caked litter for all flocks was significant less for the treated (4.1%) versus control (7.7%) pens due to decreased caked litter production in the treated pens. Percent of total nitrogen lost due to volatilization (ammonia) was significantly greater for treated pens compared to the controls in flocks 10 and 12, but was lower flocks 11 and 13. However, the difference in nitrogen loss in flocks 10 and 12 was of greater magnitude than flocks 11 and 13. Carbon analysis of litter samples showed increased C:N for top-dressed pens for all flocks, with flocks 10, 12 and 13 being significantly greater. Results of this experiment show that seasonality greatly influences nitrogen loss from the broiler rearing facility and that top-dressing of litter can increase the C:N in litter, which tends to increase nitrogen loss.

Key Words: Broilers, Nitrogen, Mass Balance

441 In house composting of layer manure for pest control. G. P. Martin*, P. H. Patterson, and C. A. B. Meyers, *The Pennsylvania State University, University Park.*

An experiment was conducted to determine the effects of mechanical pile turning/mixing with the addition of hardwood shavings to manure in deep pit layer housing. A commercial six row deep-pit poultry house were assigned treatments of : two rows each with 357.5 kg shavings base-mixed (treatment A), two rows each with 725.9 kg shavings-mixed (B), one row mixed without added shavings (T), and one row without mixing or added shavings (NT). Each treatment row was 21m long with mixing of designated rows by a belt stacking composter every 3d (approximately). Additional manure was added by the mature layers over the 51d observational period. Temperature levels in the manure were significantly greater for all treatments that were mixed with averages over the period of 50.9°C (A), 51.0 (B), 50.2 (T), 41.7 (NT). Percent moisture ranges at 51d were: 37.0(T), 37.1(B), 42.0(A), 48.3(NT). The practice of in house composting with mechanical manipulation of the pit manure may serve as a main component to an IPM program in commercial poultry housing.

Key Words: IPM, Manure, Mechanical Composting

977 Beak trimming of Leghorn pullets 1: Production effects. K. Schwan-Lardner*, H. L. Classen, and C. B. Annett, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

Strains of White Leghorn pullets are available for commercial production that may benefit from beak trimming with regards to a reduction

in cannibalism and or an improvement in feed efficiency. The objective of this work was to study the impact of age of mild beak trimming on pullet growth and hen performance. Pullets (120 of each of two strains) were designated to one of four trimming treatments: control or untrimmed (C), trim at commercial hatchery using a Zoo-Technique Robotics Machine (0d), or trim on farm at 10d or at 35d of age. Hens (90 per strain x treatment) were housed in battery cages at 17 wk of age, and photostimulated at 18wk (6 replications per strain x treatment group with 5 cages of 3 birds or 15 hens per replication). Data were analyzed as a 2 x 4 factorial analysis, with Duncans Multiple Range Test separating means when ANOVA was significant. Birds trimmed at 10 and 35d were lighter at 57d than control pullets (kg: C=0.649^A, 0d=0.647^{AB}, 10d=0.632^C, 35d=0.635^{BC}). By 85d of age and through to the termination of the experiment, body weights of all pullets were not different. Total hen day production was lower (P=0.0629) for C birds (%: C=82.3, 0d 83.3, 10d 83.7, 35d 84.4), but hen housed production did not differ. Feed intake was not affected by trimming treatments (g/hen/d: C=110.3, 0d=108.0, 10d=107.7, 35d=108.5) but because of the higher egg production and the numeric difference in feed intake, feed efficiency was poorer for untrimmed birds (TFEM: C=2.27^A, 0d=2.20^B, 10d=2.19^B, 35d=2.20^B; TFDE: C=1.61^A, 0d=1.56^B, 10d=1.54^B, 35d=1.54^B). Mortality was not different due to treatment (%: C=2.22, 0d=3.89, 10d=3.89, 35d=5.00). Cannibalism was only found in untrimmed birds, but levels were not significantly different from trimmed birds (C=0.56, 0d=0, 10d=0, 35d=0). Trimming the beaks of pullets at a young age (0, 10 or 35d) had minor effects on pullet growth and improved feed efficiency and egg production in White Leghorn birds.

Key Words: Beak Trimming, Production, Feed Efficiency

PSA - Poultry Genetics

442 Direct and correlated response from selection for phytate phosphorus bioavailability in a randombred chicken population. W. Zhang, S. E. Aggrey*, R. I. Bakalli, G. M. Pesti, and H. M. Edwards, Jr., *University of Georgia, Athens.*

This study was undertaken to evaluate the direct and correlated response to a 3 generation divergent selection for phytate phosphorus bioavailability (PBA). Individual 4-week body weight (BW), BW gain (BWG), feed consumption (FC) during a 3 d period, and feed conversion ratio (FCR) were studied as correlated responses to directed selection for PBA in Athens-Canadian randombred population. There was a significant difference between the high (H) and low (L) lines for PBA. The phenotypic difference in BW between the high and low lines at generation 3 was 26 g (P<0.01). The chickens in the low line had higher BW than the high line. There were significant (P<0.05) correlated responses in BWG, FC and FCR. The line differences in the correlated traits were due primarily to changes in the H line than the L line. The correlated responses in BW, BWG and FC were mainly due to the genetic change that had occurred in H line, and little genetic change occurred in L line across generations. The mixed model procedure with an animal model was used to separate environmental effects from genetic effects in order to establish a genetic trend for the correlated traits across the generations. Comparison between phenotypic and genetic trends indicated that, the selection experiment was influenced by environmental variation in the first two generation. It was thought that changes in PBA could be related to an internal homeostatic mechanism that limits genetic progress in the L line. There is a lower threshold of phosphorus in the diet that has to be met for chicks to feed. This provides an indication that utilization of phytate phosphorus will be limited in the L line, and as a result changes in correlated traits in this line would also be limited.

Key Words: Selection, Phytate Phosphorus Bioavailability, Chicken

443 Allele frequencies of genes associated with feed efficiency traits in selected and unselected population in a commercial broiler line. P. Sharma*, W. Bottje, and R. Okimoto, *University of Arkansas, Fayetteville.*

Various polymorphisms were identified in coding and noncoding region of genes studied in association with the feed efficiency traits. These genes included Uncoupling protein gene (UCP), Melanocortin 4 receptor (MC4R), Melanocortin 3 receptor (MC3R), and proopiomelanocortin gene (POMC). A PCR-RFLP test was developed to type the Ala118Val

polymorphism in UCP gene. Similar PCR-RFLP tests were developed for Ser76Leu polymorphism in MC4R gene and Pro61Leu polymorphism in POMC gene. UCP Val 118 allele was found to be associated with the higher feed efficiency and MC4R Leu 76 was found to be associated with the higher body weight in the selected population studied. Two populations from the same line were tested for above polymorphisms. The birds that are typed for feed efficiency are a selected population. Individuals selected based on several defined traits pass into feed efficiency trials. The population of 400 birds chosen prior to the feed efficiency selection process was screened to study the distribution and frequency of the detected polymorphisms and alleles in the unselected population. The Val118 UCP allele was found at a frequency of 0.1 among 44 birds of the selected population and at the same frequency of 0.1 in the unselected population of 400 birds. A difference in the frequency of Leu76 MC4R allele was found with the frequency of 0.435 among the selected 44 birds and 0.359 in the unselected 100 birds tested so far but the difference was not found to be significant.

Key Words: Feed Efficiency, Polymorphism, Allele Frequency

444 Quantitative trait loci affecting bone mineral density in the chicken. M. A. Schreiweis*, P. Y. Hester, and D. E. Moody, *Purdue University, West Lafayette, IN.*

Osteoporosis is a significant problem in egg-laying strains of hens. Bone fractures caused by the loss of structural bone have resulted in a loss of markets for the spent hens and created welfare concerns. The objective of the current study was to identify quantitative trait loci (QTL) associated with bone mineral density (BMD) in a chicken resource population. Layer (White Leghorn hens) and broiler (Cobb roosters) lines were crossed to generate an F2 population of 509 hens over seven hatches. Phenotypic data collected from hens in the resource population included BW at 6, 35, and 55 wk of age as well as the BMD of the left humerus and tibia at 35 and 55 wk of age. The BMD was determined using a Norland pDexa X-ray bone densitometer. Genotypes of 25 microsatellite markers were determined on chromosomes 1 and 3 using the ABI3700 and ABI Prism Genotyper software. A preliminary regression analysis was conducted using QTL Express. The statistical model included hatch as a fixed effect and additive and dominance effects for putative QTL were fit to a linear model using least squares. Chromosome-wide significance thresholds were empirically determined following 10,000 permutations. Chromosome 1 contained a QTL for humeral BMD at 35

wk of age located at 15cM ($P < 0.05$) expressing significant dominance effects ($P < 0.01$). Chromosome 3 potentially contained two QTL for tibial BMD at 35 wk of age located at 84 and 143cM ($P < 0.01$) and one QTL for 35 wk BW at 147cM ($P < 0.05$). All three QTL on chromosome 3 expressed significant additive effects ($P < 0.01$). The QTL located on chromosomes 1 and 3 explained 2.7 and 4.0% of the residual phenotypic variation for BMD of the humerus and tibia at 35 wk of age, respectively. No QTL were identified on chromosomes 1 and 3 for other traits in the analysis. Identification of additional QTL associated with BMD may facilitate selection of birds for improved bone strength through marker assisted selection. Research supported by Midwest Poultry Consortium and NRI Competitive Grants Program / USDA No. 2002-03394.

Key Words: Bone Mineral Density, Quantitative Trait Loci, Chicken

445 Molecular characterization of chicken SOCS2 gene. G. Y. Zhou* and F. C. Leung, *Department of Zoology, The University of Hong Kong, Hong Kong, China.*

Suppressor of cytokine signaling 2 (SOCS2) has been demonstrated to involve in postnatal growth in mouse, negatively regulating a wide variety of cytokine signaling like growth hormone and interleukin-6 through the JAK-STAT pathway. In Chicken, using alternative transcriptional starting sites, two transcripts of SOCS2 named variant 1 and variant 2 were discovered by 5' RACE assay. Besides, two SOCS2 proteins encoded by the variants were identified and they are composed of 156 aa and 207 aa, respectively. In order to illustrate its genomic structure, a chicken BAC clone containing the SOCS2 gene was characterized by sequencing. It was found that chicken SOCS2 gene comprises only two exons and one intron, while in human or in mouse, SOCS2 gene consists of three exons and two introns. These differences may reveal the evolutionary relationship between mammals and birds. On the other hand, RT-PCR showed that the two SOCS2 mRNAs were distributed widely in both male and female adult chicken, but the expression levels of them varied from organ to organ. In summary, chicken SOCS2 gene may modulate somatic growth of chicken as shown in mouse and

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447 Relative toxicity of gossypol isomers in laying hens. M. M. Lordelo*¹, A. J. Davis¹, M. C. Calhoun², and N. M. Dale¹, ¹*Poultry Science Department, University of Georgia, Athens,* ²*Texas A&M University Research Center, San Angelo.*

Cottonseed meal has been proposed as a protein source for poultry diets, but concern over the presence of the potentially toxic factor, gossypol, has limited its use. Gossypol is a polyphenolic compound that exists as either a positive (+) or negative (-) isomer. An experiment was conducted to determine the relative toxicity of each gossypol isomer in laying hens. Twenty-five individually caged Hy-Line W36 43 wk-old layers were fed a corn/soy diet supplemented with either 0, 200 (+), 400 (+), 200(-) or 400 (-) mg/kg of pure gossypol isomer for 20 d (5 pens /treatment). Feed intake, egg production and egg weight were monitored daily. Birds were weighed on d 1 and d 20. All eggs were individually opened and scored for yolk discoloration using a scale of 0 (no discoloration) through 10 (complete discoloration). Subsequently, yolks were separated for gossypol analysis. At the end of the experiment, tissue samples were collected for determination of gossypol isomer levels. Total egg production was equivalent for birds fed either the control or the (-) isomer diets. Birds fed the (+) isomer, however, had lower ($P < 0.05$) total egg production. After d 10, egg weight was significantly decreased from birds fed either level of the (+) isomer when compared to the control-fed birds. Eggs produced by the layers fed the (+) isomer had severe yolk discoloration. Although average egg yolk discoloration scores were equivalent between birds fed either the control diet or the diets supplemented with the (-) isomer, there were a few eggs with a score of 3 detected for the (-) isomer treatment but not for control treatment. Total feed intake was lower for birds consuming the 400 mg/kg level of (+) isomer when compared to the birds on the other treatments. Final body weights were not different between the controls and the other treatments. Tissue and yolk accumulation of the (+) gossypol isomer was higher than the (-) isomer. Additionally, there was no racemization of the isomers in the tissues and yolks of the laying hens. The results

the physiological relevance among the two isoforms of SOCS2 requires further investigation.

Key Words: SOCS2, Variants, Growth Hormone

446 Molecular cloning and characterization of a broiler small intestine Type IIb sodium phosphate cotransporter gene. F. Yan^{1,4}, C. Ashwell*^{2,3}, and R. Angel¹, ¹*Department of Animal and Avian Sciences, University of Maryland, College Park,* ²*Growth Biology Lab., Animal and Natural Resources Institute, USDA-ARS, Beltsville, MD,* ³*Department of Poultry Science, North Carolina State University, Raleigh,* ⁴*Department of Poultry Science, University of Arkansas, Fayetteville.*

Intestinal absorption and renal resorption play a critical role in overall homeostasis of phosphorus in chickens. Using RNase-Ligase-Mediated Rapid Amplification of cDNA Ends (RLM-RACE) PCR, we have obtained a cDNA from the broiler small intestine, that encodes a type IIb sodium-dependent phosphate transporter. The cDNA has an open reading frame of 2022 base pairs and predicts a protein of 674 amino acids with the calculated molecular mass of approximately 74 kDa. Amino acid hydrophathy predicts eight transmembrane domains, with intracellular NH₂ and COOH termini. The Na/Pi IIb cotransporter has high homology with other type II Na/Pi cotransporters, but low homology with the type I or type III Na/Pi cotransporters. The Na/Pi IIb transporter is located on chicken chromosome 4 at 73.61 Mb where a gene was predicted by the Ensemble database. A microsatellite marker is present within intron 5 of the genomic structure. Northern blot analysis demonstrated the presence of a single mRNA transcript present predominantly in the small intestine with the highest expression in the duodenum, followed by the jejunum and ileum. In situ hybridization indicated that the Na/Pi cotransporter mRNA is expressed throughout the vertical crypt-villus axis of the small intestine. Further study is needed to elucidate its physiological role in the intestinal absorption of phosphate in chickens.

Key Words: Small Intestine, Phosphorus, Absorption

indicate that the (+) gossypol isomer is responsible for the negative impacts associated with feeding cottonseed meal to laying hens.

Key Words: Gossypol Isomers, Cottonseed Meal, Laying Hens

448 Effect of increased heat processing on phosphorus (P) bioavailability in corn distiller dried grains with solubles (DDGS). C. Martinez Amezcua*, L. E. Markovic, and C. M. Parsons, *Department of Animal Sciences, University of Illinois, Urbana.*

A few previous studies have shown that heat processing may increase the bioavailability of phytate-P in some foodstuffs. Therefore, two chick experiments were conducted to determine the effect of various increased heat processing treatments on bioavailability of P in DDGS. In addition, two precision-fed cecectomized rooster assays were conducted to evaluate the effects of the heat treatments on amino acid digestibility, particularly lysine. For the chick assays, a P-deficient cornstarch-dextrose-soybean meal basal diet containing 0.10% nonphytate phosphorus was formulated. A standard curve was then constructed by adding 0.0, 0.05 and 0.10% P from KH₂PO₄ to the basal diet. For the DDGS treatments, a commercial sample of DDGS was obtained and then subjected to increased heat processing by autoclaving at 124 kPa and 121C or by heating in a drying oven at 121C. The various DDGS samples were then added to the P-deficient basal diet at levels of 7 to 14%. New Hampshire x Columbian male chicks were fed the experimental diets from Day 8 to 22 post-hatch, and growth performance and tibia ash were measured. Bioavailability of P was estimated using the slope-ratio method, where tibia ash was regressed on P intake from KH₂PO₄ or DDGS. In the first experiment, bioavailability of P in DDGS (% of total) was increased ($P < 0.05$) from 75 to 87% by autoclaving for 75 min. In the second chick assay, P bioavailability was significantly increased ($P < 0.05$) by autoclaving for 60 and 80 min, but not for 40 min. The effects of oven drying on P bioavailability were inconsistent. Lysine digestibility of DDGS determined by the cecectomized rooster assay was substantially decreased

by the heat treatments, particularly for autoclaving, which caused large reductions. The results of this study indicated that increased heat processing may increase P bioavailability in DDGS but will likely reduce amino acid digestibility, particularly for lysine.

Key Words: DDGS, Phosphorus, Lysine

449 High protein corn distiller dried grains as a feed ingredient. C. Abe*¹, N. J. Nagle², C. Parsons³, J. Brannon¹, and S. L. Noll¹, ¹University of Minnesota, St. Paul, ²National Bioenergy Center, Golden, CO, ³University of Illinois, Urbana.

Hydrolyzed distillers dried grains (HDG) were obtained from the National Renewable Energy Laboratory. The sample was submitted for determination of proximate components, sugar, starch, amino acid, and minerals. For digestible amino acid determination, cecatomized chicken roosters were used. Growing turkeys were used for the determination of TMEn. HDG was evaluated for feeding value by inclusion into a basal diet at 0, 5, 10, 15, and 20%. The corn-soybean meal based turkey starter diet was formulated to provide similar levels of ME, digestible lysine (lys) and methionine (met), calcium, and phosphorus. Male poult (Large White) were fed a commercial starter diet until 3 d of age. At 3 d of age, they were weighed and assigned into cages such that there was an equivalent cage body weight. Poults were fed the experimental diets to 18 d of age (Ten replicate cages/seven poults/cage). At the end of the trial, two poults per pen were randomly selected, euthanized, and internal organs (spleen, heart, liver, gastrointestinal tract, bursa) weighed. Results (as fed) for ash, DM, fat, fiber, protein, starch and sugars were 1.43, 95.9, 10.7, 3.9, 57.8, 1.6, and 2.0%, respectively. Lys, arginine (arg), tryptophan (trp), threonine (thr), cystine (cys) and met content as % of protein were 1.99, 2.63, 0.34, 3.14, and 2.1%, respectively. Digestibility coefficients of lys, arg, trp, thr, cys and met were 68.1, 79, 64, 75.2, 78.3 and 85.9% respectively. TMEn was 2692±78 kcal/kg as is. There was significant linear decrease ($P<0.01$) at 11 day of age in average daily gain (ADG) and feed intake as HDG level was increased and a cubic effect ($P<0.02$) in ADG during 11 to 18 days. In conclusion, up to 10% of HDG can be included in turkey starter diets although higher levels may be possible after two weeks of age.

Key Words: Turkey, Corn, Distillers Dried Grain

450 Mucin dynamics in the chicken gastrointestinal tract. A. Smirnov*, Z. Uni, and D. Sklan, *Hebrew University, Rehovot, Israel.*

The absorptive surface of the small intestine is covered by a layer of mucus secreted by goblet cells which acts a barrier influencing transport between luminal content and epithelial cells. Bacterial lipopolysaccharide, growth-factors, nutrients and nutritional conditions participate in regulation of mucin biosynthesis. Mucin glycoproteins modulate adherence of different bacterial species that have a role in gut health. In this study methods of analysis of mucin dynamics were established and the influence of nutritional manipulations on mucin function in chicks investigated in two different nutritional settings. In the first experiment chicks were starved for 48 hr, and in the second chicks were fed with diets with added antibiotic or probiotic. Mucin mRNA expression, mucin glycoprotein concentration, mucus adherent layer thickness and goblet cell size and numbers were measured in the jejunum. A 371-bp cDNA fragment of the chick small intestine mucin gene was isolated and was 60% homologous to human mucin MUC5AC. Mucin mRNA expression was analyzed by semi-quantitative RT-PCR. mRNA expression increased by 480% and mucin glycoprotein by 216% in the jejunum of starved chicks. Goblet cell size was increased by starvation by 100% in the jejunum. Measuring the thickness of the mucus adherent layer revealed that increased protein synthesis did not result in a thicker mucus layer. On the contrary, the mucus adherent layer exhibited a 36% decrease in jejunum of the starved chicks. This may be explained by a higher rate of mucus layer degradation in starved chicks or by changes in mucin secretion from goblet cells. Feeding antibiotic and probiotic additives changed mucin dynamics, goblet cell morphology, mucin gene expression and mucin glycoprotein concentrations. These changes may be due to alterations in the intestinal microflora. This study has indicated that regulation of mucin production, secretion and turnover in

the chick small intestine is altered by nutritional manipulations. These changes influence mucosal function and defense.

Key Words: Chick, Small Intestine, Mucin

451 Diurnal variations and quantitative determination of the generation of carboxylic acids by microbial fermentation in the crop of the domestic turkey. S. A. Johannsen*¹, M. J. Hensley³, M. A. Rasmussen⁴, R. Griffith³, and C. G. Scanes^{1,2}, ¹Department of Animal Science, Iowa State University, Ames, ²Biomedical Sciences, Iowa State University, Ames, ³Veterinary Microbiology and Preventive Medicine, Iowa State University, Ames, ⁴National Animal Disease Center, Animal Science, Iowa State University, Ames.

The roles of avian crop include storage of ingesta but it may allow fermentation. It has been shown recently in the chicken that carcass contamination can be attributed to bacterial colonization of the crop tissue when the organ ruptures during evisceration. The present studies examine intra-luminal fermentation in the crop of young turkey poults. The following carboxylic acids were detected in the crop contents: formic, acetic, butyric, lactic, valeric, caproic, oxalic, phenyl acetic, succinic and fumaric acids. Unexpectedly, propionic, isobutyric and isovaleric acids were not detectable. At the beginning of the scotophase, there were considerable ingesta in the crop of turkey poults. During the scotophase, there were changes in the amount and characteristics (pH and carboxylic acid concentrations) of the crop contents. A progressive reduction in the contents was observed. Increases in the numbers of lactobacilli during the period of subjective night were observed. The pH of the contents decreased; for example declining from 5.9 one hour after the onset of the scotophase to 5.0 nine hours after the onset of the scotophase in control turkey poults. During the scotophase, there were linear increases the concentration of lactic, valeric and caproic acids (approximately 7 fold increases over 8 hours). There were decreases in the crop concentrations of formic, oxalic and succinic acids during the scotophase. Chronic addition of lactose or *Lactobacillus* sp. to the diet exerted modest effects on the carboxylic acid concentration in the crop contents. These data indicate the importance of microbial fermentation in the crop of poults and provide evidence of diurnal variation. These factors may have an impact upon metabolism and nutrition of the turkey and poultry in general.

Key Words: Turkey, Fermentation, Crop

452 Effects of delayed placement on Villus characteristics and barrier functions of the small intestine of the newly hatched turkey. L. P. Potturi*, J. Patterson, and T. J. Applegate, *Department of Animal Sciences, Purdue University, West Lafayette, IN.*

The objectives of the research were to determine the effect of delayed access to feed, on villus development, bacterial translocation and salmonella attachment potential in turkey poults during the first wk after hatching. Poults were either given ad libitum access to water and feed immediately after hatch (FED), or delayed access to water and feed for 48 h (DLY). In the first study, the FED poults had 50 μ m longer villi, 6.8 μ m wider villi and 5.9 μ m deeper crypts when compared to the DLY poults at 5 d post-feeding ($P<0.05$). The DLY poults had fewer goblet cells per villus when compared to FED poults on 5 d post-feeding ($P=0.016$). The FED poults had a significant increase in the number of proliferating enterocytes in the villus, when compared to DLY poults, on 1, 2, and 5 d post-feeding. Apoptotic labeling was higher in DLY group compared to the FED group on 1, 2 and 5 d post-feeding. In the second study, the DLY poults had higher numbers of aerobic bacteria in the ileal digesta and ileal tissue, when compared to the FED poults on 1 d post-feeding ($P<0.05$). The number of aerobic bacteria translocated to the spleen by 5 d post-feeding was less when compared to 1 d post-feeding ($P\leq 0.05$). The FED and DLY poults challenged with salmonella were not significantly different in the number of salmonella isolated from the ileal tissue. Higher numbers of salmonella were isolated from both the treatment groups on 5 d post-feeding relative to 1 d post-feeding ($P=0.0006$). In conclusion, early access to ad libitum feed in poults stimulated the growth and development of small intestinal villi and their absorptive surface while delayed access to feed resulted in

delayed enterocyte proliferation and greater enterocyte apoptosis during the first wk post-hatch. Delayed placement increased the numbers of aerobic bacteria in the small intestine of poult shortly after hatch.

Key Words: Poult, Delayed Placement, Intestinal Development

453 Effect of dietary amino acid content on intestinal populations of *Clostridium perfringens* in broiler chickens fed high-crude protein diets. D. C. Wilkie*, A. G. Van Kessel, L. J. White, and M. D. Drew, *Dept. of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

Necrotic enteritis is a disease affecting poultry caused by *Clostridium perfringens* and is a concern to producers worldwide. Previous studies have reported that dietary protein has a significant effect on gut *C. perfringens* populations. Thus, a better understanding of the relationship between dietary protein and gut *C. perfringens* populations may result in improved control of this disease. An experiment was performed to examine the effect of dietary amino acid content on intestinal levels of *C. perfringens*. Broiler chickens (N = 192) were fed a non-medicated starter diet (31.5% crude protein) for 14 days after hatching and were orally challenged with 1 mL per day of an overnight culture of *C. perfringens* on days 14-21. On days 14-28 the 2 pens of 12 birds each were fed 1 of 7 diets containing 40% crude protein with fish meal, meat/bone meal, feather meal, corn gluten meal, soy protein concentrate, pea protein concentrate, or potato protein concentrate as the primary protein source. An eighth diet containing 23% crude protein was fed as a control. No clinical necrotic enteritis was observed, however the birds fed fish meal, meat/bone meal, feather meal and potato protein concentrate had significantly higher cecal *C. perfringens* counts than the birds fed corn gluten meal, soy or pea protein concentrates or the control diet (P < 0.05). In the ileum, *C. perfringens* counts in the birds fed fish meal, meat/bone meal and feather meal were significantly higher than in the birds fed corn gluten meal, soy or pea protein concentrates or the control diet (P < 0.05). Correlation analysis was done between the amino acid content of the diets and *C. perfringens* numbers in ileum and cecum. The glycine content of the diets was significantly correlated with *C. perfringens* numbers in ileum (r = 0.923; P < 0.05) and cecum (r = 0.840; P < 0.05). No other significant correlations were observed. The results suggest that the glycine content of diets is an important factor predisposing broilers to the intestinal overgrowth of *C. perfringens* and clinical necrotic enteritis.

Key Words: Clostridium Perfringens, Broiler Chicken, Amino Acid

454 Molecular tracking of *Bifidobacterium animalis* colonization in the gastrointestinal tract of broiler chickens using quantitative real time PCR (qPCR). S. A. Briggs*¹, T. J. Dumonceaux¹, B.G. Goldade¹, J. K. Marshall¹, J.E. Hill², S. M. Hemmingsen², and A. G. Van Kessel¹, ¹University of Saskatchewan, Saskatoon, SK, Canada, ²National Research Council, Saskatoon, SK, Canada.

To evaluate molecular quantification of specific bacteria in the intestine a qPCR assay was developed to enumerate *Bifidobacterium animalis* (ATCC 27536) using PCR primers designed on chaperonin 60 gene sequence, SYBR Green fluorescence detection of PCR product accumulation and a standard curve based on genomic DNA extracted from pure *B. animalis* culture. Primer specificity was confirmed with standard PCR and a panel of genomic DNA from 30 bacterial species, including 7 *Bifidobacterium* spp. Specific amplification of *B. animalis* in a complex background was confirmed by sequencing of PCR products generated from cecal contents. To test the assay in vivo, 216 broiler chickens were arranged in a 2X3 factorial design, such that birds (6 birds/pen) were fed a corn-soy starter diet (CP 20.8% AME 3.1 kcal/g) containing 0, 1.5 or 3% guar gum (GG) and orally gavaged with 10⁸ cells of *B. animalis* or water on days 1, 3, 5, 7 and 9 after hatch. Bifidobacteria(BA), coliforms(CO) and *B. animalis* genomes were enumerated using Beerens agar, MacConkeys agar and the qPCR assay, respectively in ileal and cecal contents collected on days 7, 14 and 21 after hatch. Addition of 1.5 and 3.0 % GG to diets increased (P<0.05) BA in ileum on day 14 and increased BA, CO and *B. animalis* genomes in cecum on all sampling days. Gavage increased (P<0.05) *B. animalis* genomes detected in ileum on day 21 but not days 7 or 14. In cecum, gavage increased (P<0.05) BA detected in all diets on day 7 and in the 0% GG diet on day 21, however, gavage did not affect the number of CO or *B. animalis* genomes in cecum. DNA extracted from only 1 of 15 colonies isolated

from pooled cecal contents cultured on Beerens agar could be amplified with *B. animalis* specific primers. Results demonstrate that qPCR assays can be used to enumerate bacteria in intestinal contents of poultry and offer markedly improved specificity vs. culture-based analysis.

Key Words: Poultry, qPCR, Bifidobacterium

455 The effect of glutamine on growth performance and the development of the gastrointestinal tract and immune system of broilers. S. M. Bartell* and A. B. Batal, *University of Georgia, Athens.*

Two experiments were conducted to evaluate the effect of glutamine (Gln) on growth performance, development of the gastrointestinal tract and immune system. Immediately after hatch six replicate pens of six chicks were randomly assigned to one of the seven (Experiment 1) or five (Experiment 2) dietary treatments for 21 d. On Day 0, 4, 7, 14, and 21 twelve chicks per treatment were sacrificed for thymus, spleen, bursa, duodenum, jejunum, ileum, bile, and blood sample collections and/or weights. In Experiment 1, the effect of 1 or 4% Gln addition to the feed, water, or both was compared to a corn-soybean meal (SBM) control diet. All diets were formulated to be isocaloric and isonitrogenous. Weight gain was significantly (P < 0.05) improved at 4, 14, and 21 d of age when chicks were fed diets with 1% Gln as compared to chicks fed the corn-SBM control (10% average improvement). The addition of 4% Gln to the water depressed (P < 0.05) growth performance through out the 21 d study and appeared to be toxic. There was an advantage of 1% Gln in the feed and water on the spleen and thymus weights. The addition of 4% Gln in the feed resulted in heavier duodenum and jejunum weights but a depression in weight gain. From experiment 1, 1% Gln supplementation to the diet was determined to be ample and most practical. Thus in experiment 2, 1% Gln was fed for 4, 7, 14, or 21 d after which time chicks were fed the corn-SBM control diet. Weight gain was significantly (P < 0.05) improved when chicks were fed 1% Gln as compared to chicks fed the corn-SBM control. The best performance was observed when the chicks were fed the diet with 1% Gln through out the 21 d study. The relative thymus weight of chicks fed diets with 1% Gln was higher than that of chicks fed the corn-SBM diet. In both experiments, concentrations of bile and plasma IgA were increased in the chicks fed diets with 1% Gln for 21 d. Our results indicate that the addition of Gln to the diet of broiler chicks improves growth performance and may stimulate development of the gastrointestinal tract and immune system.

Key Words: Glutamine, Gastrointestinal Tract, Broiler Chicks

456 Feeding a semi-purified diet induced early gut development in young turkey poults. Y. O. Fasina*¹, J. D. Garlich², H. L. Classen³, Z. Uni⁴, P. R. Ferket², and S. R. Mckee¹, ¹Auburn University, Auburn, AL, ²North Carolina State University, Raleigh, ³University of Saskatchewan, Saskatoon, SK, Canada, ⁴Faculty of Agriculture, Hebrew University, Rehovot, Israel.

Delayed access of newly hatched poultry to feed is known to result in higher poult mortality, sub-optimal intestinal development, and subsequent reduction in market weight. Sub-optimal functional maturation of the intestine early in the brooding period is one of the main constraints to optimal early growth of precocial birds (Konarzewski et al., 1990; Ricklefs et al., 1998). We propose that providing a diet that is capable of inducing intestinal maturation early in newly hatched poults is one way of improving early poult performance. Thus, an experiment was conducted to compare the ability of a corn starch-casein-based semi-purified diet (PD) and a conventional corn-soybean meal diet (SBD) to induce early intestinal development and growth in young poults. Each experimental diet contained 0.5 % titanium dioxide as an indigestible marker and was fed to 56 poults in four replicate pens (14 poults per pen) from 0 to 14 days of age. Body weight gain and feed efficiency of birds were recorded on days 7 and 14. Intestinal maturation was assessed by measuring the levels of brush border enzymes (maltase and alkaline phosphatase) on days 7 and 14. Fecal samples were collected during days 5 to 7 and days 12 to 14 of the experiment to evaluate nutrient digestibility. On day 7, although poults fed the SBD digested fat better (p < 0.05) than poults fed the PD, the latter poults had higher (p < 0.05) weight gain, feed efficiency and brush border enzyme levels. However, by day 14, the performance of poults fed the SBD improved such that the SBD treatment was similar or better to the PD treatment in all parameters assessed. It is concluded that the PD is superior to the

SBD in inducing early intestinal development in poults, but this benefit is significantly realized only during the first week of poult life.

Key Words: Turkey Poults, Early Intestinal Development, Semi-Purified Diet

PSA-Nutrition: Amino Acids and Vitamin/Mineral Nutrition II

457 Dietary lysine response by broilers in two photoperiods. O. C. Aimuwu* and M. S. Lilburn, *The Ohio State University/OARDC, Wooster.*

Within the broiler industry there is a move toward producing heavy broilers for the production of deboned breast meat. The management of heavy broilers typically involves some degree of photoperiod restriction to minimize the incidence of growth related anomalies (i.e. ascites). An experiment was conducted to establish a lysine response range for commercial broilers between 6 and 8 weeks of age. Diets were formulated to contain 0.70 (Control), 0.82, 0.94 and 1.06 percent total lysine. Acid insoluble ash (celite) was included in each diet to allow for ileal digestible lysine determination. Each diet was fed to broilers in four replicate floor pens (n=15 birds per pen) in each of two rooms. The birds in Room A had a 16 hour photoperiod beginning at 4 days of age whereas the birds in Room B had a 22 hour daily photoperiod. In each room, half the birds in each treatment were weighed and processed on days 15 and 16 of the experiment. In addition to body weight and feed conversion (pen basis), the weights of the pectoralis major and minor breast muscles were also recorded. The maximal response to lysine (body weight, breast muscle weight) occurred at 0.94 % total lysine (88% digestible lysine; $P < 0.05$). At the highest level of lysine (1.06 % total lysine, 92% digestible lysine) weight gain declined. There was a significant increase in lysine digestibility as dietary total lysine increased (Dig. Lysine = $60.5 + 29.9 \times (\text{total lysine})$; $r^2 = 0.72$; $P < .0001$). This was most likely due to the increasing proportion of synthetic lysine added as dietary total lysine increased. There were no significant photoperiod effects or diet by photoperiod interactions.

Key Words: Broilers, Digestibility, Lysine

458 A comparison of amino acid digestibility coefficients between chickens and turkeys. O. C. Aimuwu*¹, C. M. Parsons², and M. S. Lilburn¹, ¹*The Ohio State University/OARDC, Wooster*, ²*University of Illinois, Urbana.*

There is a paucity of information on comparative amino acid digestibility coefficients in chickens and turkeys. An ileal digestibility study with turkeys was conducted with five week-old turkey toms. Semi-purified diets were formulated with corn, wheat, soybean meal, meat and bone meal, feathermeal, and fishmeal as the sole sources of dietary protein. Toms were reared in litter floor pens until the beginning of the experiment (35 days) when they were moved into Petersime growing battery cages (3 toms per cage). Each diet was fed to three replicate pens and the experimental period was five days. Birds were killed by cervical dislocation on day 5 and ileal digesta was collected between Meckels diverticulum and the ileal caecal junction. Samples of each of the experimental diets were sent to the University of Illinois for true amino acid digestibility determination using cecectomized adult roosters. The coefficients for the essential amino acids (EAA) lysine, methionine, and arginine in corn were fairly similar between the species but threonine digestibility was considerably lower in turkeys (72%) than roosters (88.5%). The digestibility coefficients for arginine, lysine, and methionine in soybean meal were 4 to 6% higher in roosters and the threonine differences were similar to what was observed for corn. Some of these differences could be due to the measurement of apparent digestibility in turkeys versus true digestibility in roosters. There was good similarity between the species for most of the EAA in meat and bone meal whereas in fishmeal, EAA digestibility was consistently higher in roosters than in turkeys.

Key Words: Digestibility, Roosters, Turkey

459 Valine needs of broilers from 21 to 42 days of age. S. A. Thornton*, S. J. Barber, A. Corzo, and M. T. Kidd, *Mississippi State University, Mississippi State.*

Valine is typically considered the fifth limiting amino acid in commercial broiler diets based on corn and soybean meal (CS). Three experiments

were conducted to evaluate Val needs for growth and carcass responses in Ross 508 broilers (d 21 to 42). All birds received a common diet from d 1 to 20. Experiment (Exp) 1 was a Val-test-diet validation experiment conducted with males randomly allocated across 30 battery pens (5 birds/pen). Dietary treatments for Exp 1 included: a test diet containing 0.72% Val (0.64% digestible (dig)) or 0.82% Val (0.73% dig) as achieved via L-Val supplementation, and a CS control diet containing 0.82% Val (0.73% dig) equaling NRC (1994) Val. Both Exp 2 and 3 were Val dose responses in male and female broilers, respectively. In Exp 2 and 3, birds were randomly distributed across 48 floor pens per Exp (12 birds/pen) and fed Val graduations (0.64 to 0.87% in 0.045% increments). In Exp 1, growth measurements were not affected ($P > 0.05$) by dietary treatments. Fat and carcass weight, and carcass yield did not differ ($P > 0.05$), but percentage fat was increased ($P \leq 0.05$) in birds fed low Val (15.6% CP) compared to birds fed the CS diet (18.0% CP). Because differences in BW gain ($P = 0.16$; 0.72% Val, 1.34 kg; 0.82% Val, 1.41 kg; and 0.82% Val in the CS control, 1.40 kg) did not occur, the test diet used to titrate Val in Exp 2 and 3 was decreased to 0.64% Val (0.57% dig). Quadratic responses in Exp 2 and 3 did not occur. Linear responses to increasing Val were observed for BW gain and feed conversion ($P \leq 0.05$) in males, and breast meat yield ($P = 0.07$) in females. Increasing Val to 0.73% (0.65% dig) improved ($P \leq 0.05$) BW gain and feed conversion in males, but not females, over broilers fed 0.64% Val (0.57% dig). Results indicate that diets based on CS containing 0.73% Val (0.65% dig) should support good live performance and processing traits for 21 to 42 d old males, but females may need less. The 21 to 42 d NRC (1994) Val recommendation of 0.82% is safe, but may be overestimated.

Key Words: Amino Acid, Broiler, Valine

460 Changes in the digestible lysine and sulfur amino acid needs of broiler chicks during the first 21 days posthatching. A. R. Garcia*, T. D. Troutman, and A. B. Batal, *University of Georgia, Athens.*

Two experiments were conducted to study the digestible lysine (DL) and sulfur amino acids (DSAA) requirements of broilers during the first wk of age, and to evaluate how the requirements change during the first 21 d. Male broiler chicks were randomly assigned to 5 replicate pens of 6 chicks per treatment from 0 to 21 d. The experimental diets, based on corn, soybean meal, and corn gluten meal (experiment 1), were formulated to be isocaloric and isonitrogenous, varying only in the level of the amino acid being tested. In experiment 1, the levels of DL used were 0.92, 1.02, 1.12, 1.22, 1.32%. In experiment 2, the levels of DSAA were: 0.65, 0.75, 0.85, 0.95 and 1.05%. Body weights and feed intake were recorded at d 4, 7 and 21, and body weight gain (BWG) and gain:feed ratio (GF) were calculated for each period. The digestible amino acid requirements were estimated by broken-line methodology, fitting the data to a quadratic curve (90%) and determining the first point at which the quadratic response curve intersects the plateau of the one slope broken-line. Estimated requirements reported herein are based on results of the broken-line analysis. In experiment 1, the DL requirement based on BWG and GF increased slightly with age, 1.02% at d 4 to 1.05% at d 7 and 1.12% at d 4 to 1.14% at d 7, respectively, with little to no change thereafter. The DL requirement based on BWG was lower than the estimated requirement based on GF. In experiment 2, the estimated DSAA requirement based on BWG gradually decreased from 4 to 21 d (0.85, 0.84 and 0.80% at 4, 7 and 21 d, respectively), whereas the requirement based on GF did not change during the first wk, but increased slightly from 7 to 21 d of age (0.75% at d 4 and 7 and 0.78% at d 21). Results from these studies suggest there is little change in the DL requirement during the first three wk posthatch. The observed decrease in the DSAA requirement during the first 21 d does not match the expected increase needed for feathering. Studies conducted to date do not support the

hypothesis that the amino acid needs of broilers are high immediately after hatch.

Key Words: Lysine, Sulfur Amino Acids, Broiler Chicks

461 Broiler growth in response to increased lysine in the first week post hatching. S. Pophal*, S. L. Vieira, A. M. Kessler, A. R. Ebert, and B. B. Gallo, *UFRGS*.

Recent research has demonstrated an influence of early starvation on the growth of broilers leading to a permanent loss in the breast muscle synthesis. This loss seems to be related to myonuclei accretion from satellite cells. Broiler responses at a late age may also be related to malnutrition. Since Lys is very important to the synthesis of breast muscle protein, its deficiency may also be involved. In this study, male broiler chicks of two strain crosses (A and B) were fed diets with increased Lys levels (0.82%, 0.99%, 1.16% and 1.33% dig Lys) from hatching to 7 days. Feeds were based on corn and soybean meal and formulated to contain 2,950 ME kcal/kg and to be ideally balanced for essential amino acids. All other nutrients met or exceed NRC recommendations (1994). Each treatment had 5 replicates with 50 birds per pen at the beginning. Birds of all treatments received common commercial feeds from 8 days to 7 weeks. One bird per replicate was slaughtered weekly and its weight and the weight of its digestive organs, abdominal fat, feathers and commercial cuts were evaluated. Results showed that strain crosses exhibited different growth patterns with strain cross A being heavier through the first 5 weeks, but strain B being heavier at 6 and 7 weeks. Differences between strains also included a better feed conversion for strain cross B through all the experiment. A faster development of feathers was seen for birds of the strain cross A at 2 and 3 weeks of age. A positive linear relationship was observed between increasing Lys levels in the first week and body weight, body weight gain, carcass weight, and breast muscle mass to 6 weeks of age; however, this trend did not remain in the following week. No effect of Lys on organ weight, feather growth, and on the yield of the carcass and commercial cuts were detected. Lys deficiency in the first week leads to losses in meat production of broilers grown to body weights targeting most of the market needs.

Key Words: Lysine, Breast Meat Yield, Broiler

462 Withdrawn by author. . .

463 Development of a whole cell sensor – green fluorescent protein based method for estimating lysine bioavailability in poultry feed proteins. V. I. Chalova*, W. K. Kim, I. B. Zabala-Díaz, C. L. Woodward, and S. C. Ricke, *Texas A&M University, College Station*.

Lysine can be one of the more limiting amino acids in protein sources for animals. Therefore, an accurate pre-determination of bioavailable lysine in feedstuffs is important. An optical density (OD) based microbiological assay for lysine determination using *E. coli* lysine auxotroph has been previously developed. However, because the assay is based on bacterial growth response to extracellular lysine measured as OD, it can be relatively time consuming (10-12h). Therefore, more rapid assays are needed. The purpose of our study was 1) to develop a whole cell fluorescent biosensor for lysine by introducing *gfpmut3* into the genome of an *E. coli* Δ LysA::bla, a deletion mutant lysine auxotroph, and 2) to compare lysine availability values of the bacterial assay with an in vivo chick growth assay. The fluorescent signal emitted by GFPmut3 was used to construct a standard curve as a function of lysine concentration to estimate the quantity of lysine available in respective poultry feed protein samples. Based on the fluorescence emitted by GFPmut3 we constructed a standard curve after 6 hour growth of the strain. Using the newly developed lysine fluorescent whole cell sensor we determined the total as well as the bioavailable amount of lysine in casein. The lysine recoveries were $97 \pm 1.65\%$ and $103.9 \pm 4.66\%$ respectively for the two levels ($12 \mu\text{g/ml}$ and $30 \mu\text{g/ml}$) of casein acid hydrolysate. We also determined the amount of bioavailable lysine in three feed samples (soybean, cotton seed meal, meat and bone meal) and compared with the data obtained from the chick bioassay. The bioavailable lysine as estimated by in vitro microbial assay was $3.09 \pm 0.74\%$ for soybean, $1.17 \pm 0.16\%$ for cotton seed meal and $1.74 \pm 0.06\%$ for meat and bone meal and $2.47 \pm 0.022\%$,

$1.28 \pm 0.049\%$ and $1.64 \pm 0.067\%$ respectively determined by chick bioassay. When the data obtained by microbial and animal assays were compared statistically, a correlation of 99% was observed. The results suggest that microbial assay using GFP fluorescence is highly comparable to conventional chick assays for estimating lysine bioavailability from these typical poultry feed protein sources.

Key Words: Lysine Bioavailability, *E. Coli*, Chick Bioassay

464 The effect of several oligosaccharides on true amino acid digestibility in cecectomized and intact roosters. P. E. Biggs* and C. M. Parsons, *Department of Animal Sciences, University of Illinois, Urbana*.

Prebiotics, such as indigestible oligosaccharides, are considered to be possible dietary alternatives to antibiotic growth promoters in poultry. The effects of indigestible oligosaccharides on nutrient digestibility in poultry are largely unknown. Therefore, an experiment was conducted to evaluate the effects of several oligosaccharides on amino acid digestibility in roosters. The dietary treatments consisted of a corn-soybean meal control diet or that diet supplemented with 4 or 8 g/kg of inulin (IN), oligofructose (OF), mannanoligosaccharide (MOS), short-chain fructooligosaccharide (SCFOS), or trans-galactooligosaccharide (TOS). Each of the 11 diets was tube-fed (30 g) to four cecectomized and four intact Single Comb White Leghorn roosters that had been fasted for 24 h. Excreta were then collected for the following 48 h, freeze-dried, and analyzed for amino acid content. The digestibility of lysine and valine was increased ($P < 0.05$) in cecectomized roosters fed 8 g/kg MOS or TOS when compared to roosters fed the control diet. In addition, methionine digestibility was improved ($P < 0.05$) in cecectomized roosters fed 4 g/kg MOS or SCFOS and 8 g/kg OF or TOS. The true digestibility of isoleucine was increased ($P < 0.05$) in cecectomized roosters fed 8 g/kg MOS or 4 or 8 g/kg TOS. The magnitude of the increases in amino acid digestibility coefficients for cecectomized roosters ranged from 3 to 9 percentage units. Feeding either 4 or 8 g/kg IN to intact roosters decreased ($P < 0.05$) the true digestibility of methionine. The amino acid digestibility coefficients for all other dietary treatments were not significantly different from the control treatment. The results of this study indicated that the indigestible oligosaccharides had no significant effect on the digestibility of most amino acids in a corn-soybean meal diet. The digestibility of a few amino acids, however, was increased by some oligosaccharides in cecectomized roosters but not in intact roosters.

Key Words: Amino Acid Digestibility, Oligosaccharide, Cecectomized Rooster

465 Zinc-Methionine enhances the intestine development and functionality in the late term embryos and chicks. E. Tako*¹, P. R. Ferket², and Z. Uni¹, ¹*Department of Animal Sciences, Faculty of Agriculture, Hebrew University, Rehovot, Israel*, ²*Department of Poultry Science, College of Agriculture and Life Sciences, North Carolina State University, Raleigh*.

Early function of the digestive tract is crucial for achieving the maximal growth and development of broilers. Studies in mammals, demonstrated the importance of zinc to intestinal crypt cell production & restitution. Although zinc is essential in almost all aspects of metabolism, its influence on the intestine has never been investigated in chicken. The Zinc-Methionine (ZnMet), an organic form of zinc feeding additive was used in this study. This research examined the effect of In Ovo feeding (IO) solutions, containing ZnMet on the broiler embryos and chicks intestine functionality & development from 17d of incubation till 7d posthatch. At 17d of incubation, 100 fertile eggs per group were injected into the amnion, 1ml IO of .4% saline solutions containing either ZnMet (.05%) or ZnMet (.05%) plus carbohydrates (3% Maltose, 3% Sucrose, 12% Dextrin) and β -hydroxy- β -methylbutyrate (.1% HMB). The control group was injected with 1ml of .4% saline. Results showed that both IO-fed groups, exhibit increased villus surface area compare to control (elevation of 70% at 19d of incubation & 60% at 7d). At hatch the IO-fed groups had higher brush border activity levels of Sucrase-Isomaltase (SI) & leucine-Aminopeptidase (AP) (.2 mM glucose/g & 18mM pnitroalilide/g respectively, as compare to .15 mM glucose/g & 10mM pnitroalilide/g in controls). Also at hatch, all the IO-fed birds exhibited higher ($P < 0.05$) mRNA levels of SI, AP, Sodium-glucose cotransporter (SGLT1) & ATPase genes compare to controls. Use of RTPCR isolated & sequenced fragment (303bp) of chicken ZnT1 zinc transporter, revealed 2 fold increase in mRNA levels of ZnT1 at

hatch in the IO groups compare to controls. In conclusion, birds IO-fed ZnMet, had an improved digestive & absorptive capacity. However, the IO solution contained ZnMet added to carbohydrates & HMB had a long term effect on intestinal morphological development, expression and activity of brush border enzymes and transporters.

Key Words: Broiler, Intestine, Zinc-Methionine

466 Effect of vitamin D source on broiler production and carcass composition. J. L. Saunders-Blades* and D. R. Korver, *University of Alberta, Edmonton, AB, Canada.*

The effect of vitamin D source and time of feeding 25-OH vitamin D₃ (HyD[®]) on broiler production efficiency and carcass composition was studied. The first hydroxylation of vitamin D in the liver results in 25-OH vitamin D₃ (25-OHD₃); providing dietary 25-OHD₃ to the bird reduces the need for this hydroxylation, potentially allowing for a more efficient use of vitamin D. The dietary treatments differed only in supplemental vitamin D source: the Control diet contained 3,000 IU/kg of vitamin D₃, the 25-OHD₃ diet contained 69 µg/kg of 25-OHD₃. Four dietary treatments were fed: Control (Control diet from 1-41 d), 25-OHD₃ (25-OHD₃ diet from 1-41 d), 25-OHD₃ Early (25-OHD₃ diet from 1-28

d, Control diet from 29-41 d), or 25-OHD₃ Late (Control diet from 1-28 d, 25-OHD₃ diet from 29-41 d). Birds were reared sex separately in 32 pens, with 4 replicates per treatment within each sex. Feed consumption and BW were measured at 0, 10, 28 and 41 d. At 42 d, 80 birds from each male pen were randomly selected for carcass and portion yield analysis. Birds in the 25-OHD₃ and 25-OHD₃ Early groups had a greater BW gain than the Control and 25-OHD₃ Late groups from 11-28 d, gaining 55 and 55 vs 53 and 53g·bird⁻¹·d⁻¹, respectively (P<0.05). By 42 d, birds fed the 25-OHD₃ treatment were heavier than those fed the Control and 25-OHD₃ Late treatments (2301 vs 2233 and 2234 g, respectively; P<0.05). All treatment groups maintained similar feed conversion efficiencies (P>0.05). Starved and eviscerated BW and absolute weight of the pectoralis major, wings and drums were greater for the 25-OHD₃ fed birds than those fed the Control and 25-OHD₃ Late treatments (P<0.05). Overall, the 25-OHD₃ treatment supported a faster BW gain, and greater breast and leg portions. All groups in this study developed field rickets around 11 d, however symptoms subsided and no treatment was administered. The results of this study are therefore confounded by the rickets, but may indicate that 25-OHD₃ helped to lessen the effects of rickets as shown by the greater growth rate.

Key Words: Broiler Production, Vitamin D, 25-OH-vitamin D₃

Ruminant Nutrition: Beef - Minerals & Vitamins

467 Effects of trace mineral source and feeding method on the productivity of grazing Braford cows. J. D. Arthington*¹ and C. K. Larson², ¹*Range Cattle Research and Education Center, University of Florida, Ona,* ²*Zinpro Corporation, Eden Prairie, MN.*

Braford cows (n = 160) were used to evaluate the effects of trace mineral source and feeding method on cowherd productivity over 3 yr. In yr 1, cows were stratified by age and randomly allocated to one of eight groups (n = 20 cows/group). Cows were allotted to eight of 16 bahiagrass pastures (8.0 ha each, one empty pasture between groups) and were rotated each week. Cow groups remained intact throughout the study with the exception of culled cows, which were replaced with 3-yr-old pregnant heifers. Cows were offered 2.27 kg of liquid molasses daily from early November until middle of April. One mature Braford bull was placed into each cow group starting in early January, remaining for 90 d. Bulls were rotated through cow groups each week. Two main factors were randomly applied to groups in a 2 x 2 factorial arrangement (two groups/treatment), consisting of 1) trace mineral source; inorganic vs organic, and 2) mineral feeding method; free-choice vs control-fed in a molasses supplement. Cow BW, body condition score (BCS), pregnancy rate, calving interval, and calf BW at weaning were obtained. Mineral intake was measured each week in pastures provided free-choice mineral. In yr 1 and 2, liver biopsy collections, for the determination of mineral status, were conducted at the start and end of winter supplementation on the same six randomly chosen cows/group. Cows assigned to free-choice treatments consumed 23% less (P < 0.001) mineral compared to control-fed cows, resulting in a greater (P < 0.05) decrease in liver Zn (yr 1) and liver Cu (yr 2) concentration compared with control-fed cows. Mineral source and feeding method had no effect on cow BW, cow BCS, and calf BW at weaning. Young cows (3 and 4 yr of age) consuming organic minerals had a greater pregnancy rate during yr 2 (P < 0.05) and 3 (P = 0.15) and a lesser (P < 0.05) calving interval in yr 1 and 3, compared to cows consuming inorganic minerals. The supplementation of organic minerals (Cu, Zn, Mn, and Co) appears to increase the reproductive performance of young, but not mature, grazing Braford beef cows consuming molasses-based supplements.

Key Words: Cattle, Mineral, Molasses

468 Effects of Tri-Basic Copper Chloride Vs Copper Sulfate on Measures of Copper Status and Forage Intake in Growing Beef Heifers. J. D. Arthington* and F. M. Pate, *Range Cattle Research and Education Center, University of Florida, Ona.*

Previous research indicates that growing beef cattle may experience increased DMI when supplemented with tri-basic copper chloride (TBCC) vs an organic Cu source. The objective of this study was to investigate the effect of supplemental TBCC vs Cu sulfate on the Cu status and DMI of growing heifers fed forage-based diets. Twenty-four crossbred heifers were stratified by BW (355 ± 10.4 kg) and randomly allotted to

individual pens. Heifers were provided free-choice access to ground grass hay (8.0 and 54.0% CP and TDN, respectively) and 1.75 kg/d of a corn-cottonseed meal supplement. Three treatments were randomly allocated to pens, providing; 1) 100 mg/d Cu from Cu sulfate, 2) 100 mg/d Cu from TBCC, or 3) 0 mg Cu/d (Control). Forage DMI was measured daily. Individual heifer BW, jugular blood, and liver biopsy samples were collected on d 0, 30, 60 and 90. Heifer ADG was not affected (P = 0.83) by Cu treatment (average = 0.22 ± 0.07 kg). Change in liver Cu and plasma ceruloplasmin (Cp) concentration did not differ (P > 0.16) among Cu sources (120 vs. 77 ppm liver Cu, and -6.0 vs. 3.5 mg/dL Cp for Cu sulfate and TBCC supplemented heifers, respectively; SEM = 20.6 and 3.1). Heifers fed no supplemental Cu experienced a lesser (P < 0.001) accumulation of liver Cu and a greater decrease (P < 0.04) in Cp concentration over the 90-d supplementation period (-34.4 ± 20.6 ppm liver Cu and -4.1 ± 3.1 mg/dL Cp) compared to both Cu sulfate and TBCC supplemented heifers. Forage DMI did not differ among Cu sources, however, heifers provided no supplemental Cu had lower (P < 0.05) forage DMI compared to both Cu sulfate and TBCC supplemented heifers (average forage DMI = 4.9 and 5.3 kg/d for Control and Cu supplemented heifers, respectively; SEM = 0.14). These data indicate that Cu sulfate and TBCC are of similar availability when offered to growing beef heifers in corn-cottonseed meal supplements. As well, these data indicate that the lack of supplemental Cu may decrease forage DMI in growing beef heifers.

Key Words: Copper, Forage, Cattle

469 Effect of chromium supplementation and copper status on glucose metabolism in beef cows. H. S. Stahlhut*, C. S. Whisnant, K. E. Lloyd, E. J. Baird, L. R. Legleiter, S. L. Hansen, and J. W. Spears, *North Carolina State University, Raleigh.*

Pregnant Angus (n=83) and Simmental (n=69) cows were blocked by age and assigned to one of two free choice mineral supplements to determine the effect of dietary Cr and Cu status on glucose metabolism. Supplements consisted of: 1) control (no supplemental Cr) and 2) 40 mg Cr /kg (from Cr picolinate). Mineral supplements were formulated to contain all minerals typically supplemented to cattle diets with the exception of Cu. At the beginning of the study (75 d prepartum) one-half of cows in each treatment received a 25 g Cu oxide needle bolus. Blood was collected from 35 cows on d 28, 58, 97 (20 d postpartum), and 155 for plasma glucose. Plasma glucose concentrations were affected by time (P< 0.01), breed x Cu bolus (P< 0.05), and Cr x time (P< 0.05). In non-Cu supplemented cows, plasma glucose was higher (P< 0.05) in Angus than in Simmental. In animals receiving a Cu bolus, plasma glucose was similar in both breeds. On d 97, plasma glucose levels were lower (P< 0.01) in cows receiving Cr relative to controls. Plasma glucose was not affected by Cr at other sampling d. At approximately 1 mo prepartum and 1 mo postpartum, 12 cows were cannulated and glucose tolerance tests (GTT) were conducted. Plasma glucose concentrations

following the GTT conducted prepartum were lower ($P < 0.01$) in Cr-supplemented than in control cows (86.3 vs 91.8 mg/dL), but glucose clearance rates were not significantly affected by treatment. In postpartum GTT, plasma glucose was affected by an interaction between Cr-supplementation and Cu status. Chromium-supplemented animals that received a Cu bolus had higher ($P < 0.001$) plasma glucose (92.2 vs 69.2 mg/dL) than cows not supplemented with Cu after glucose administration. No significant difference in plasma glucose was observed between control cows regardless of Cu status. Results of this study indicate that plasma glucose is lower in cows receiving supplemental Cr and that an interaction between Cr and Cu status may alter glucose metabolism.

Key Words: Chromium, Copper, Glucose, Cattle

470 Growth, reproductive performance, and manganese status of heifers fed varying concentrations of manganese. S. L. Hansen*, C. S. Whisnant, K. E. Lloyd, E. J. Baird, L. R. Legleiter, H. S. Stahlhut, and J. W. Spears, *Department of Animal Science, North Carolina State University, Raleigh.*

Eighty Angus ($n = 40$) and Simmental ($n = 40$) heifers, averaging 10 mo of age and 245 kg in BW, were used to determine the effects of dietary Mn on performance, reproduction, and Mn status of heifers. Heifers were stratified by age within a breed and randomly assigned to treatments consisting of a control diet (analyzed 20 mg Mn/kg DM) supplemented with 0, 10, 30 or 50 mg Mn/kg DM. Diets were offered ad libitum using Calan gate feeders. Blood samples were taken on d 0, 63, and 98 for plasma cholesterol and Mn analysis. Liver biopsies were taken on d 0 and 98. Average daily gain, DMI and G:F for the 140-d period were not affected by Mn. Initial liver Mn was not affected by breed. Liver Mn concentrations on d 98 were affected by a treatment by breed ($P < 0.05$) interaction. Simmental heifers supplemented with 30 or 50 mg Mn/kg diet had higher ($P < 0.05$) liver Mn than controls. Liver Mn in Angus heifers was not affected by dietary Mn. Plasma cholesterol was higher ($P < 0.05$) in Angus compared to Simmental heifers, especially on d 0. On d 63 control heifers had lower ($P < 0.07$) plasma cholesterol (151 vs 196 mg/dL) than heifers supplemented with 50 mg Mn/kg DM. Plasma cholesterol was not affected by Mn treatment on d 98. Cholesterol values across treatments increased ($P < 0.01$) over time. Based on serum progesterone concentrations at or greater than 1 ng/mL, 40% of control heifers were cycling at approximately 12 mo of age compared to 50% of Mn-supplemented heifers. At approximately 13 mo of age 40% of control heifers exhibited signs of estrus, in response to a two-shot Lutalyse synchronization protocol, compared to 50% of those supplemented with 50 mg Mn/kg DM. The percentage of heifers cycling at 12 or 13 mo of age was not significantly affected by treatment. Results of this study indicate that 20 mg Mn/kg diet DM is adequate for growth of heifers, but may be inadequate for maximum reproductive performance.

Key Words: Manganese, Heifers, Reproduction

471 Influence of dietary manganese on performance and serum glucose concentrations in growing steers. L. R. Legleiter*, K. E. Lloyd, and J. W. Spears, *Department of Animal Science, North Carolina State University, Raleigh.*

Manganese requirements of beef cattle are poorly defined. This study was conducted to determine the effect of dietary Mn on performance and serum glucose concentrations of growing cattle. One hundred twenty Angus cross steers were bunk fed a corn silage-based diet for 84 d in a confined feeding facility with slatted concrete floors. Steers were blocked by weight and randomly assigned to one of six treatments (four blocks, 24 pens, 5 head/pen) providing increasing levels of Mn in the form of manganese sulfate. The 12.9% CP basal diet, provided ad libitum, consisted of corn silage (78%), corn gluten feed (18%), urea, trace minerals and vitamins. Treatments consisted of 0, 10, 20, 30, 120 and 240 mg supplemental Mn/kg DM. The control diet without supplemental Mn analyzed at 30.2 mg Mn/kg DM. Steers were weighed every 28 d. Blood samples were taken 2 h post feeding from eight steers per treatment on day 56. Data were analyzed as a completely randomized block design using the GLM procedure of SAS. Initial weight (247.5 ± 1.2 kg) and final weight (354.2 ± 6.3 kg) were not different ($P > 0.05$) between treatments. Average daily gain was similar ($P > 0.05$) among all treatments and averaged 1.27 kg/d. Likewise, DMI and feed efficiency were similar ($P > 0.05$) across treatments averaging 6.68 kg/d and 0.19 (G:F, kg/kg), respectively. Additionally, serum glucose concentrations averaging 80

mg/dL were not different ($P > 0.05$) between treatments. These data suggest that a corn silage-based growing diet containing Mn at 30 mg/kg DM adequately meets the growing requirements of steers in confinement.

Key Words: Manganese, Cattle, Glucose

472 Selenium in tissues of calves supplemented with selenium yeast. C. J. Richards*, H. M. Blalock, L. C. Miller, and H. D. Loveday, *The University of Tennessee, Knoxville.*

An experiment was conducted to evaluate supplementation of Se yeast (Sel-Plex[®]; Alltech Inc, Nicholasville, KY) in a finishing diet balanced to contain adequate Se from feedstuffs. Forty Angus and Angus crossbred steers and heifers (20 steers, 20 heifers) were blocked by sex and randomly allotted to eight pens (5 hd/pen). Calves were acclimated to grain using common diets varying in Se concentration, but always supplemented with 0.2 mg Se/kg diet (DM) from sodium selenite. After adaptation, pens were randomly assigned, within sex, to a basal finishing diet containing adequate Se from cracked corn, alfalfa pellets, corn gluten pellets, molasses and a Se free vitamin/mineral supplement (CON) or the basal finishing diet plus 0.27 mg Se/kg diet (DM) from Se yeast (SUP). Two pens of each sex received each treatment for 130 d with weights and blood samples taken at 28 d intervals and prior to shipping. Calves were shipped overnight to a commercial harvesting facility where hot carcass weights were recorded and samples of each liver lobe collected. After a 48 hr chill, yield grade, quality grade, back fat, and KPH were determined and a loin muscle sample obtained. The CON and SUP diets contained an average of 0.15 and 0.43 mg Se/kg diet (DM), respectively. No difference ($P > 0.01$) in calf weights, ADG, feed intake, feed efficiency or any carcass measures were detected. Serum Se had a treatment by time interaction ($P < 0.01$) where initial serum Se concentrations were similar (0.09 mg/mL). Thereafter, CON calves had lower ($P < 0.01$; average = 0.08 mg/mL) serum Se concentrations than SUP calves (average = 0.11 mg/mL). Loin Se concentrations were lower ($P < 0.01$) for CON than SUP calves (0.135 and 0.258 mg Se/kg as-is tissue, respectively). Liver Se concentration increased ($P < 0.01$) from 0.426 to 0.831 mg Se/kg as-is tissue with SUP. Results of this experiment indicate that supplementing 0.27 mg Se/kg diet (DM) from Se yeast in a feedlot diet containing adequate Se does not increase animal performance, but does result in increased Se tissue concentrations that do not exceed the FDA limit.

Key Words: Ruminant, Selenium, Beef

473 Determining the route and amount of P excreted from cattle consuming finishing diets. B. G Geisert*, G. E Erickson, T. J. Klopfenstein, M. K. Luebke, and J. C MacDonald, *University of Nebraska, Lincoln.*

Determining the amount and the route of phosphorus (P) excretion is important due to the increasing pressure to manage P in animal waste. This experiment was designed to determine the amount and the route of P excreted from cattle fed a high energy finishing diet with different amounts of P. Five ruminally fistulated crossbred steers were used in a 5x5 latin square design. Diets consisted of 3 brewers grit based diets formulated for 0.12% P (LOWP) with monosodium phosphate added to increase P level to 0.27 (MEDP) and 0.42% P (HIGHP). They consisted of 50% course brewers grits, 20% dry rolled corn (DRC), 15% corn bran, 5% grass hay, 5% molasses, and 5% supplement. The other 2 diets were a DRC based diet (CORN), and a dry distillers grain diet (DDGS, 57% DRC, 30% DDGS, 5% grass hay, 5% molasses, and 3% supplement). Diets contained 0.12, 0.27, 0.42, 0.30, 0.36 % P (DM basis) for LOWP, MEDP, HIGHP, CORN, DDGS, respectively. Steers were adapted to diets for 16 days with a 5-day collection period. Chronic oxide was dosed at 5 grams every 12 hours for the last 8 days of each period. Total urine was collected and analyzed for P concentration. Fecal samples were taken 3 times daily, composited by day and analyzed for P and chromium concentrations. There were no significant differences in DMI ($P > 0.05$). P intakes were 10.5, 26.7, 37.9, 29.5, 34.6 g/d for LOWP, MEDP, HIGHP, CORN, DDGS, respectively. P excretion was related to P intake and was lower ($P < 0.05$) for LOWP. Route of excretion whether feces or urine, was also affected by dietary P intake. Steers fed LOWP excreted very little P in urine (0.50 g/d). However, if diet P was $> 0.20\%$ more P was excreted in urine (2.1 g/d), but was not different across diets and was variable among animals. P retention

was lower (2.0 vs. 13.8 g/d) for LOWP than other diets, suggesting that cattle fed 0.12% P were deficient and excreting 85.3 % of the P fed.

Key Words: Excretion, Phosphorus, Cattle

474 Effects of dietary supplemental vitamin A concentration on growth, intake, and marbling in yearling feedlot steers. T. C. Bryant^{*1,3}, J. J. Wagner², T. E. Engle³, K. L. Dorton³, P. D. Burns³, and M. L. Galyean^{4,1}, ¹ContiBeef LLC, Boulder, CO, ²Continental Beef Research, Lamar, CO, ³Colorado State University, Fort Collins, ⁴Texas Tech University, Lubbock.

Recent research has shown a negative correlation between marbling and serum retinol concentration in Japanese Black cattle. Three hundred sixty single-source black, yearling steers (average initial BW = 316 ± 9.1 kg) fed a 91 % concentrate (steam-flaked corn base) diet were used to evaluate the effects of supplemental vitamin A concentration on performance, DMI, and carcass traits. Steers were blocked into eight weight replicates and assigned randomly to pens (n = 9/pen) and to diets containing 0, 1,103, 2,205 4,410, or 8,820 IU of supplemental vitamin A/kg DM. Daily DMI, ADG, and feed:gain ratio were determined for each 28-d period and for the overall 142-d trial. Final BW (586, 580, 590, 584, and 584 kg for 0, 1,103, 2,205 4,410, and 8,820 IU vitamin A/kg DM, respectively) did not differ (P > 0.10) among treatments. Feed efficiency, ADG, and daily DMI also did not differ (P > 0.10) among treatments within each 28-d period or for the overall trial. From d57 to harvest, average DMI (10.33, 10.28, 10.57, 9.75, and 10.22 kg/steer daily for 0, 1,103, 2,205, 4,410, and 8,820 IU vitamin A/kg DM, respectively) was lower (P < 0.02) for steers receiving 4,410 IU vitamin A/kg DM than for steers in other treatments, and DMI was greater (P = 0.06) for the 2,205 IU vitamin A/kg DM treatment than for the 8,810 IU/kg DM treatment. Marbling score, hot carcass weight, longissimus muscle area, and 12th rib fat thickness did not differ (P > 0.10) among treatments. Similarly, the number of carcasses grading ≥ Choice (62.6, 52.8, 64.0, 58.4, and 58.4 % for 0, 1,103, 2,205, 4,410, and 8,820 IU vitamin A/kg DM, respectively), Select, or ≤ Standard did not differ (P > 0.10) among treatments. Results of this trial suggest that vitamin A supplementation up to twice the NRC-suggested concentration has little effect on performance or marbling in typical yearling feedlot steers.

Key Words: Cattle, Marbling, Vitamin A

Ruminant Nutrition: Dairy - Lactation, Health & Gut Physiology

476 Effect of dietary cation-anion difference and crude protein on milk yield and blood metabolites of lactating dairy cows. C. D. Wildman^{*}, J. W. West, and J. K. Bernard, *The University of Georgia, Tifton.*

Eight ruminally cannulated lactating Holstein cows averaging 47 ± 10 DIM were used in a 12 wk replicated 4 x 4 Latin Square trial to determine the relationship between dietary cation-anion difference (DCAD) and dietary crude protein (CP) concentration. The study was conducted from March 28 through June 19. Treatments were arranged as a 2 x 2 factorial to provide 15 or 17% CP and DCAD of 25 or 50 meq/100 g DM (Na+K-Cl). As DCAD increased from 25 to 50, increases (P < 0.01) in DMI (17.8 to 19.1 kg/d), yield of 3.5% fat-corrected milk (20.2 to 23.7 kg/d), energy-corrected milk (20.5 to 23.8 kg/d), fat (0.6 to 0.8 kg/d) and protein (0.7 to 0.8 kg/d) were observed. Blood Na and bicarbonate (P < 0.05, P < 0.01) were greater for DCAD 50 (144 and 24.5 mmol/L) compared with 25 (143 and 22.3 mmol/L). Blood Mg decreased (P < 0.01) as DCAD increased from 25 to 50 (2.5 to 2.2 mg/dl). An increase (P < 0.01) in blood pH (7.46 to 7.50) was also noted with increasing DCAD. Urinary bicarbonate:creatinine ratio was higher (P < 0.01) for DCAD 50 (2.6) versus 25 (0.6). Greater microbial crude protein production, indicated by uric acid:creatinine ratio, was noted with increasing DCAD at low CP compared to that observed with high CP, resulting in an interaction (P < 0.05). Fractional excretion of K was greater (P < 0.01) for DCAD 50 (78.8) compared to DCAD 25 (38.3) whereas fractional excretion of Mg (P < 0.05) was reduced for high DCAD (9.6) relative to low DCAD (13.0). A DCAD x CP interaction (P < 0.05) was observed for fractional excretion of Na with an increase in DCAD resulting in increased excretion of Na at both high and low CP. The magnitude of the increase was greater at low CP compared to that observed

475 Effects of feeding a polyclonal antibody preparation against *Streptococcus bovis* or *Fusobacterium necrophorum* on performance and carcass characteristics of feedlot steers. C. R. Dahlen², N. DiLorenzo^{*1}, A. DiCostanzo¹, G. C. Lamb², and L. J. Smith¹, ¹Department of Animal Science, University of Minnesota, St. Paul, ²North West Research and Outreach Center, Crookston, MN, ³North Central Research and Outreach Center, Grand Rapids, MN.

Steer calves (n = 226; 272 kg), stratified by weight and housed in 16 pens, were used to evaluate effects of feeding a polyclonal antibody preparation (Ab; sprayed onto a soyhull pellet) against *Streptococcus bovis* (AbSb) or *Fusobacterium necrophorum* (AbFn) on performance and carcass characteristics for 153 d. Pens were randomly assigned to one of four dietary treatments resulting from a 2 X 2 factorial arrangement that included AbSb or AbFn. Diets (1.39 Mcal NEg/kg DM, 12.5% CP, 0.7% Ca, and 0.35% P) were formulated with high-moisture corn and dry ground corn (50:50 mix, DM basis), corn silage, and supplement. Interaction terms for final and carcass-adjusted final weight, gain and carcass-adjusted gain were significant (P < 0.05). Steers receiving AbSb or AbFn had heavier (P < 0.05) final BW resulting from faster (P < 0.05) daily gains. Adjusted-final weights of steers fed AbSb were heavier (P < 0.05) than those fed both or no Ab. Only AbSb was effective (P = 0.08) at enhancing carcass-adjusted daily gain. Interestingly, steers receiving both Ab gained similarly (P > 0.05) as steers fed no Ab. Interaction terms were significant (P < 0.05) for feed efficiency (analyzed as gain-to-feed), and tended (P < 0.08) to be significant for carcass-adjusted feed efficiency. Steers receiving AbSb were more efficient (P < 0.06) than those receiving both or no Ab. Steers receiving AbSb were more efficient (carcass-adjusted; P < 0.09) than those receiving both or no Ab. Steers supplemented with AbSb had heavier carcasses (P < 0.05), which accounted for greater (P < 0.05) subcutaneous fat, and greater (P < 0.05) yield grades than those of steers fed both or no Ab. These results demonstrate that feeding a polyclonal antibody preparation against *Streptococcus bovis* or *Fusobacterium necrophorum* influences performance and carcass characteristics of feedlot cattle fed high-grain diets.

Key Words: *Streptococcus bovis*, *Fusobacterium necrophorum*, Steers

at high CP. Results indicate that increasing DCAD improves intake and performance, which suggests improved N utilization on lower CP diets.

Key Words: Dietary Cation-Anion Difference, Dietary Crude Protein

477 Effect of dietary cation-anion difference and dietary crude protein degradability on milk yield and blood metabolites of lactating dairy cows. C. D. Wildman^{*}, J. W. West, and J. K. Bernard, *The University of Georgia, Tifton.*

Eight ruminally cannulated lactating Holstein cows averaging 180 ± 10 DIM were used in a 12 wk replicated 4 x 4 Latin Square trial to determine the relationship between dietary cation-anion difference (DCAD) and protein degradability (UIP). The study was conducted from August 8 through November 6. Diets were formulated to provide 15% dietary crude protein (CP) across all treatments. Treatments were arranged as a 2 x 2 factorial to provide DCAD of 25 or 50 meq/100 g DM (Na+K-Cl) and 33 or 42% of CP as UIP. Increasing DCAD from 25 to 50 increased (P < 0.01) DMI (17.0 to 18.0 kg/d), 3.5% fat-corrected milk (19.1 to 20.0 kg/d), fat (0.6 to 0.7 kg/d), and energy-corrected milk (19.5 to 20.4 kg/d) yield. A significant DCAD x degradability interaction (P < 0.01) was observed for each of these parameters with the magnitude of the DCAD effect much greater at 42% UIP compared with 33% UIP, where no difference was observed. Blood bicarbonate (22.5 to 24.4 mmol/L) and pH (7.41 to 7.43) increased (P < 0.01) as DCAD increased from 25 to 50, respectively. Urinary bicarbonate increased (P < 0.01) at DCAD 50 (69.1 mmol/L) over that observed at DCAD 25 (20.3 mmol/L). A DCAD x UIP interaction (P < 0.05) was observed for uric acid:creatinine ratio, an indicator of microbial crude protein production, because a decrease was observed with DCAD 50 versus 25 at 33%UIP (0.5 to 0.4) but no differences were observed between DCAD for 42%

UIP. Fractional excretion of Na (0.3 to 0.9), K (35.8 to 61.6), Cl (0.26 to 0.76), and bicarbonate (1.07 to 5.65) increased while Mg (11.54 to 7.36) and Ca (1.4 to 0.3) decreased ($P < 0.01$) as DCAD increased from 25 to 50, respectively. No interactions were noted for fractional excretion of minerals or blood parameters. Results of this trial indicate that increasing DCAD in diets with high concentrations of UIP can improve intake and performance of lactating dairy cows by improving dietary protein utilization.

Key Words: Dietary Cation-Anion Difference, Protein Degradability

478 Maternal undernutrition from early- to mid-gestation versus throughout gestation: Effects on visceral organs of ewes and their fetuses. B. W. Hess^{*1}, K. A. Vonnahme², E. J. Scholljegerdes¹, S. L. Lake¹, J. D. C. Molle¹, V. Nayigihugu¹, R. L. Atkinson¹, P. A. Ludden¹, L. R. Miller¹, and S. P. Ford¹, ¹Department of Animal Sciences, University of Wyoming, Laramie, ²Department of Animal and Range Sciences, North Dakota State University, Fargo.

Twenty-one multiparous ewes were used to determine the influence of maternal nutrient restriction on visceral tissues of the ewe and fetus. Control (CON) ewes (n = 4 singles; n = 4 twins) were fed pelleted beet pulp fortified with vitamins and minerals to meet requirements. From d 28 to 78 of gestation, the remaining ewes were fed 50% of CON. Beginning on d 78 of gestation, nine undernourished ewes were fed CON (UC, n = 4 singles; n = 5 twins) whereas four undernourished ewes continued to be fed 50% of CON until d 135 of gestation (UU, n = 2 singles; n = 2 twins). Rations were adjusted weekly for BW changes throughout the experiment. All ewes were slaughtered on d 135 of gestation, and ewe visceral tissues and fetal digestive tracts were measured. Eviscerated BW (EBW; $P = 0.02$) and weights of the lungs ($P = 0.03$) and heart ($P = 0.07$) were reduced in UU ewes. Total digestive tract weights were less ($P = 0.06$) for UU ewes because of reduced ($P = 0.10$) weights of the stomach, small intestine, and colon. However, the pancreas, liver, and heart of UU ewes were greater ($P = 0.11$; % of EBW) than CON or UC ewes. The weights of fetal digestive tracts were less ($P = 0.09$) for UU fetuses due to reduced ($P = 0.04$) stomach weights. Because of reduced ($P = 0.03$) EBW for UU fetuses, fetal digestive tract components (% of EBW) were not affected ($P = 0.18$ to 0.95) by dietary treatment. Twin fetuses had lighter ($P = 0.11$) EBW, but heavier ($P = 0.01$) stomach weights (% of EBW) than single fetuses. Undernourishment during gestation will decrease maternal and fetal digestive tract weights in a manner proportional to decreased BW. The ability of ewes and their fetuses to maintain equal or greater relative weights of visceral organs (% of EBW) despite being undernourished may be necessary to ensure proper physiological function.

Key Words: Ewes, Fetus, Visceral Organs

479 Energy requirement of close-up dairy cows grazing pasture. J. R. Roche^{*1}, E. S. Kolver¹, and J. K. Kay^{1,2}, ¹Dexel, Hamilton, New Zealand, ²University of Arizona, Tucson.

Fifty-two multiparous grazing dairy cows (BW:442±65.2kg) were randomly allocated to four levels of pasture DMI for 27±9.6 days precalving. Cow DMI was 1.3, 2.0, 2.3 and 2.6% of BW of fresh pasture. Following calving, all cows were grazed together and offered pasture to appetite. Daily milk yields were recorded postcalving and fat, protein and lactose concentrations determined on 2 days each wk for 5 wk. Blood was sampled 17 d precalving, on the day of calving and on d 1, 2, 3, 4, 7, 14, 28 and 35 postcalving. Loss of BW precalving was linearly ($P < 0.001$) related to precalving feeding level and only cows consuming 2.6% BW gained BW at a rate that suggested a positive energy balance. This was supported by a quadratic decrease ($P < 0.001$) in plasma NEFA and BHBA, a linear decrease ($P < 0.05$) in growth hormone (GH), and a corresponding quadratic increase in IGF-1 ($P < 0.001$), leptin ($P < 0.1$) and glucose ($P < 0.05$), as precalving DMI increased. Apart from GH and IGF-1, where differences in plasma concentrations remained during the colostrum period, precalving DMI did not change postcalving plasma concentrations of these metabolites. Similarly, precalving DMI did not affect milk yield or the yield of fat, protein or lactose in milk, although BW loss increased ($P < 0.001$) postcalving with increasing precalving level of feeding. Based on changes in BW, these results indicate that 6.0 Mcal ME/100kg BW was required precalving to maintain cow energy balance, considerably more than is currently recommended.

However, precalving DMI did not affect milk production. Further research is required to determine if an interaction exists between pre- and postcalving level of feeding.

Variable	Pre- calving DMI (% BW)				SED	P- value	
	1.3	2.0	2.3	2.6		DMI	L
ME Intake (Mcal/100 kg BW)	3.3	5.1	5.8	6.4	0.51	<0.001	<0.001
Milk yield, kg/d	19.7	21.1	19.3	20.6	1.48	0.85	0.45
Fat, %	4.79	4.81	5.10	5.05	0.238	0.75	0.48
Protein, %	3.72	3.79	3.77	3.77	0.078	0.55	0.30
Postcalving DMI, %BW	3.0	3.0	2.8	2.6	0.227	0.26	0.06
BW at calving, kg	424	441	458	468	8.1	<0.001	<0.001
BW change precalving, kg/d	-1.2	-0.1	0.5	0.9	0.41	<0.001	<0.001
BW change postcalving, kg/d	-1.0	-1.3	-1.6	-2.0	0.27	<0.001	<0.001

Key Words: Transition Cow, Pasture, Energy Balance

480 Potential for dairy feeds to harbor an invasive mold (*Aspergillus fumigatus*): Implications to herd health. S. B. Puntenney^{*}, Y. Wang, and N. E. Forsberg, Oregon State University, Corvallis.

Ruminant animals are susceptible to mycotic infections. The most-frequently encountered mycotic infections include *A. fumigatus* and *Candida albicans*. The most common sites for infection are the GI tract (omasum, abomasum and Peyer's Patches) and the lung. Symptoms of mycoses include coagulopathies and death. Factors which increase susceptibility to mycoses include immunosuppression, acidosis, anti-microbials, BVD and stress. At present, the significance of mycotic infections to dairy production is not certain. Dairy feeds, especially silages and commodities which are poorly managed, have potential to support growth of pathogenic molds. *A. fumigatus* is a thermotolerant, ubiquitous mold which prefers an acidic environment. It requires oxygen, a food source and moisture for growth. Poor handling of commodities and silages increases the possibility of mold growth. In this study we surveyed the prevalence of *A. fumigatus* in common dairy feeds. A quantitative Sybr-Green real-time PCR assay was developed to assess concentrations of *A. fumigatus* DNA. Seventy-three samples were obtained from dairies in Oregon. Feed samples were dried and ground and then DNA was extracted for Sybr-Green PCR analysis. Mean concentrations of *A. fumigatus* (spores/g) were: corn (11,286), corn/barley mix (33,156), SBM (158), beet pulp (26,966), whole cottonseed (15,363), distillers dried grains (11,516), wheat mill run (6,480), grass silage (9,304), corn silage (14,785) and spoiled silage (1,300,000). We conclude that dairy cows will be continually exposed to *A. fumigatus* and that spoiled silages harbor the highest concentrations of this invasive mold. Additional factors (e.g., stress or acidosis) are likely required to permit mycoses to develop in an individual animal. Healthy humans are resistant to *A. fumigatus* infection. Immunosuppression increases susceptibility of an individual to infection. It is possible that stress and immunosuppression in ruminants similarly predispose to mycotic infection.

Key Words: *A. Fumigatus*, Dairy Feeds, Immunosuppression

481 Is ruminal acidosis related to high diet fermentability or low buffer recycling? D. Sauvant^{*1} and D. Mertens², ¹Département Des Sciences Animales, Institut National Agronomique Paris Grignon, Paris, France, ²US Dairy Forage Research Center, West Madison, WI.

Rumen pH is the outcome of the balance between organic acids produced by diet fermentation and buffer recycling through salivation and chewing. The aim was to elucidate if one of these factors is more important than the other in ruminal acidosis. A database was compiled from 102 published experiments (nexp) containing 264 treatments. To be included in the database, an experiment must have variation in dietary

proportion of concentrate or NDF (NDF = 39.5 ± 13.7 % DM) and provide data on ruminal pH (pH = 6.21 ± 0.34), liquid outflow rate (LOR = 12.1 ± 4.0 L/kg DM), and ruminally digested OM (rdOM = 39.5 ± 10.3 % DM). The LOR is an index of buffer recycling/kg DMI and rdOM is an index of VFA production/kg DMI. The compiled data also included dry matter intake (DMI = $2.81 \pm .87$ % LW) and Acetate/Propionate ratio (A/P = 3.18 ± 0.89). Data were analyzed using GLM procedure to separate variances among and within experiment. On 52 experiments and 132 treatments when ruminal pH was compared to rdOM, there was no significant relationship among or within the diets. In contrast, the small regression standard deviation (rsd) indicated that ruminal pH was fairly accurately explained within diets by LOR: pH = $4.90 + 0.15(\text{LOR}) - 0.003(\text{LOR}^2)$; n = 86, nexp = 35, rsd = 0.09. With the A/P ratio, another index of ruminal perturbation, there was a curvilinear relationship with rdOM: A/P = $-0.59 + 0.50(\text{rdOM}) - 0.011(\text{rdOM}^2)$; n = 79, nexp = 32, rsd = 0.46. However, the corresponding relationship was more accurate with LOR: A/P = $-0.57 + 0.52(\text{LOR}) - 0.014(\text{LOR}^2)$; (n = 75, nexp = 30, rsd = 0.30). In conclusion, this summary of published research indicates that perturbations in ruminal pH and A/P are related more to LOR, which is linked to diet fibrosity indexes and chewing activity, than to differences in dietary variation linked to rdOM.

Key Words: Acidosis, Ruminal Digestibility, Ruminal pH Turnover

482 Design of a bovine metabolism gene array. B. E. Etchebarne*, W. Nobis, M. S. Allen, and M. J. VandeHaar, *Michigan State University, East Lansing.*

First generation microarrays employing extensive cDNA libraries have allowed high numbers of both known and unidentified genes to be surveyed. Many of these arrays have only one spot per gene, leaving no margin for measurement error and giving no information on variance of replication. The Human Genome Project has provided extensively annotated databases, such as Locuslink, the Kyoto Encyclopedia of Genes and Genomes (KEGG), The Institute for Genomics Research (TIGR), and BioCarta. These publicly available resources, paired with recent price reductions in oligonucleotide synthesis, allow researchers to feasibly design and produce microarrays with gene sets tailored to specific research areas. Using these databases, we identified approximately 2000 bovine genes representing enzymes of metabolic pathways, metabolic regulators and receptors, transport and binding proteins, intracellular signaling cascades, and cell cycle and apoptotic pathways. Three individual 70mer oligonucleotide probes per gene were designed for triplicate spotting onto glass slides, giving nine spots per gene. Each oligonucleotide was designed within specific parameters to standardize hybridization behavior. Use of multiple oligonucleotides per gene improves representation of the expressed fraction of each gene, including splice variants. High spot replication improves within-array quality control and increases the statistical power of detecting small changes in

expression at a lower cost than slide replication. Statistical power is especially important for metabolic research, in which changes in gene expression are often subtle. In addition, our focus on only those genes that are relevant to metabolism improves downstream bioinformatics and data analysis for integration of metabolic gene networks. Because all genes included in this design are annotated with corresponding human homologs, the design can be applied to other species to promote our understanding of comparative metabolism. In conclusion, our design of a focused oligonucleotide microarray with multiple spots per gene will facilitate research in the metabolic genomics of cattle and can be easily applied to other species and disciplines.

Key Words: Microarray, Metabolism, Statistical Power

483 Effect of increasing ruminal valerate, caproate, and heptanoate on splanchnic metabolism of VFA absorbed from the washed reticulorumen of steers. N. B. Kristensen*¹ and D. L. Harmon², ¹*Danish Institute of Agricultural Sciences, Tjele, Denmark,* ²*University of Kentucky, Lexington.*

Four steers fitted with a ruminal cannula and chronic indwelling catheters in the mesenteric artery, mesenteric vein, hepatic portal vein, hepatic vein, as well as in the right ruminal vein were used to study the absorption and metabolism of VFA from bicarbonate buffers incubated in the temporarily emptied and washed reticulorumen. Each treatment was incubation of a bicarbonate buffer in the rumen for 90 min and continuous infusion of ruminal infusate to maintain a constant rate of VFA disappearance. Treatments were control (VFA mixture) or added valerate (VAL), caproate (CAP) or heptanoate (HEP). With the control the ruminal disappearance rates were 585 ± 24 , 257 ± 10 , 12 ± 0.4 , 118 ± 3 , and 17 ± 1 mmol/h of acetate, propionate, isobutyrate, butyrate, and valerate, respectively. With VAL, the valerate disappearance increased to 99 ± 1 mmol/h. Ruminal disappearance of caproate and heptanoate were 57 ± 1 and 60 ± 0.4 mmol/h with CAP and HEP, respectively. Net portal flux (68 vs. 39 ± 2 mmol/h) and splanchnic flux (22 vs. 10 ± 1 mmol/h) of butyrate increased ($P = 0.01$) with VAL compared with control. The concentration difference of butyrate between artery and ruminal vein increased ($P = 0.01$; 0.242 vs. 0.120 ± 0.007 mmol/kg blood) with VAL compared with control indicating that butyrate metabolism by the ruminal epithelium was inhibited by the increased valerate. Net portal flux of caproate and heptanoate accounted for 54 and 43% of the ruminal disappearance, respectively. The splanchnic flux of caproate and heptanoate accounted for less than 2% of the ruminal disappearance rate indicating complete metabolism by the splanchnic-drained viscera. Caproate and heptanoate affected rumen epithelial butyrate metabolism less than the increased valerate.

Key Words: Cattle, Energy Metabolism, Volatile Fatty Acids

ALPHARMA Beef Cattle Symposium: Factors Affecting Feedlot Profitability

484 Assessing the cost of beef quality. J. D. Lawrence*, C. Forristall, and G. May, *Iowa State University, Ames.*

The number of U.S. fed cattle marketed through a value-based or grid marketing system is increasing dramatically. Most grids reward Choice or better quality grades and some pay premiums for yield grades. The Choice-Select (C-S) price spread increased 55 percent, over \$3/cwt during the 1990s. However, there is a cost associated with pursuing these carcass premiums both in the feedlot and the cowherd. Correlations between carcass and performance traits resulted in economic tradeoffs that change across input costs and quality grade premiums and discounts. Feedlot profitability was largely determined by marbling, carcass weight, and feed efficiency. Carcass weight was most important at a low C-S spread but give way to marbling at average and higher quality premiums. Data suggests that cow size and marling score are negatively correlated. The current trend toward wider C-S spreads places greater emphasis on marbling ability of calves. These correlations and results suggest that higher marbling is associated with lower cost cows to maintain.

Key Words: Beef, Feedlot Profits, Grid Marketing

485 The effect of cattle health on performance, production costs, and carcass value. R. L. Larson*, *College of Veterinary Medicine, Commercial Agriculture Program, University of Missouri, Columbia.*

Bovine respiratory disease (BRD) and possibly other diseases may detrimentally affect weight gain, carcass weight, rib eye area, marbling, and meat tenderness of feedlot cattle. Gardner et al. (1999) found steers with lung lesions had lighter hot carcass weights, lower dressing percentage, less internal fat, and lower marbling scores than steers without lesions. Steers with lung lesions also tended to have less external fat and smaller longissimus muscle area than healthy counterparts.

A clear mechanistic pathway linking disease to changes in growth and carcass traits has not been described. In their review of feedlot cattle growth, Owens et al. (1995) summarized that rate and composition of tissue accretion may be controlled by chronological age, physiological age, energy intake, hormonal status, relative turnover of tissues, cell number, and cell activity. Disease could conceivably impact all of these control processes except chronological age. There are three possible mechanisms by which disease may impact growth and carcass traits. First, metabolic signals such as cytokines and cortisol could have an effect on carcass composition through modification of hypothalamic secretions of thyrotropin-releasing hormone, by inhibition of IGF-I and insulin actions on muscle and fat tissues, and by direct protein catabolism

and lipolysis. Second, disease-induced anorexia could decrease serum IGF-I and increase serum GH which causes irreversible change in the partitioning of nutrients for tissue deposition. Ward et al. (1992) found that fasted cattle have higher serum cortisol concentrations than do fed cattle. Cortisol may be involved in anorexia-associated decreases in carcass weight and fatness through decreased thyroid hormone activity and increased protein catabolism. Third, cytokines and endotoxin induce various behavioral symptoms of sickness including lethargy, adipisia, and reduced social interactions. The result may be an indirect effect of anorexia on growth and carcass traits in that sick cattle are effectively on feed for fewer days than healthy penmates.

Key Words: Respiratory Disease, Cattle, Carcass Value

486 Effects of nutrition and management on carcass value and profitability. L. L. Berger* and N. A. Pyatt, *University of Illinois, Urbana.*

As increasing numbers of cattle are being marketed on a grid basis, carcass value rather than live weight is becoming the primary determinant of profitability. Carcass value is determined by weight, quality grade, yield grade, choice-select spread, and premiums and discounts. Early-weaned steers (n = 192, Simmental or greater) of known genetics were individually fed in a four-year study to determine performance and carcass factors explaining variation in carcass value and profitability. Steers were weaned at 88.0 ± 1.1 d and fed a high concentrate diet

(\$108.99/T) for 84.5 ± 0.4 d prior to allotment. Steers consumed a 90% concentrate diet (\$98.93/T), consisting primarily of whole shelled corn and corn silage, for 249.7 ± 0.7 d and harvested at 423.3 ± 1.4 d of age. Five-year price data were collected for feedstuffs, dressed beef, and grid premiums and discounts. Average dressed beef price was \$110.67/45.4 kg. Premiums (\$/45.4 kg) were given for Prime (\$5.62), premium Choice (\$1.50), yield grades (YG) 1 (\$2.46), 2A (\$1.31) and 2B (\$1.11). Discounts (\$/45.4 kg) were given for Standard (-\$17.72), Select (-\$8.90), YG 3A (-\$0.12), 3B (-\$0.19), 4 (-\$14.16) and 5 (-\$19.56), and hot carcass weight (HCW) extremes (409-431 kg, -\$0.64; 432-454 kg -\$11.39; > 454 kg, -\$19.71). Input costs included annual cow costs (\$327.77), veterinary/medical and labor (\$35/hd), feed markup (\$22/T), yardage (\$0.25/hd/d) and interest (10%). Dependant variables were carcass value and profit per steer. Independent variables were yearling weight EPD, marbling EPD, daily DMI, ADG, feed efficiency, HCW, 12th rib fat, calculated YG and marbling score (MS). Carcass value was correlated ($P < 0.05$) with yearling weight and marbling EPD, DMI, ADG, feed efficiency, HCW and MS. Carcass weight, MS and YG accounted for over 79% of the variation in carcass value among steers; explaining 57, 12 and 10%, respectively. Profit was correlated ($P < 0.05$) with DMI, ADG, feed efficiency, HCW and MS. Marbling score, DMI, ADG, YG and HCW accounted for over 77% of the variation in profit among steers; explaining 30, 14, 12, 12 and 9%, respectively

Key Words: Carcass Value, Quality Grade, Yield Grade

Companion Animal Symposium

487 Nutritional management of obese animals. G. D. Sunvold*, *The Iams Company Research and Development, Lewisburg, OH.*

Being overweight or obese is the single most common nutritional disease in companion animals. Traditional weight management technology involves diluting dietary calories with fiber. The potential side effects of high fiber diets will be noted in the presentation. An alternative weight management strategy, managing the underlying physiological changes that occur in overweight animals or put these animals at risk for obesity, will be discussed. The close relationship between obesity and glycemia makes it important to study glucose and insulin metabolism in order to effectively treat obesity. This metabolic association will be discussed. The role of several nutrients for use in weight management has been examined and will be an important aspect of this presentation.

Key Words: Dogs, Cats, Obesity

488 Humans and companion animals: hand-in-paw towards aging and obesity. B. T. Larson*, D. F. Lawler, Y. Pan, and J. R. Jackson, *Nestle Purina PetCare Co.*

The effects of aging are relentless. In response to aging, living organisms make functional, physiological and zoometric adaptations. Beyond these seemingly pre-ordained genetic and physiological adaptations, there are

increasing adverse effects upon aging mediated through obesity. The relative abundance of inexpensive, entertaining, and delectable food energy sources combined with a lack of immediacy or initiative to use calories through physical activity has caused an epidemic of obesity. Statistics regarding obesity in humans and companion animals compels science to explore available options. Scientific knowledge surrounding obesity and aging is growing at a remarkable rate. New revelations have been made of adipose tissue's regulatory effects on whole-body physiology (insulin resistance, ex.). In addition, obesity is related to chronic disease development (osteoarthritis, organ function, cancers, ex.) through insulin sensitivity. These new developments have opened new venues in the science of aging and obesity. Additionally, the aging-related loss of lean tissue mass physiologically intersects with age-associated fat tissue deposition to multiply downstream physiological effects. Unfortunately, this exponential knowledge growth exceeds population implementation rate. How companion animal science approaches these issues is critical to implementation. What is the science component in the aging and obesity implementation equation? Given, that science agrees to disagree about mechanistic theories, how is interim credibility preserved with partners outside science? Who are sciences potential partners in the aging and obesity implementation equation? What might this partnership look like in order to curb the acceleration of obesity in aging companion animals?

Key Words: Companion Animals, Aging, Obesity

Dairy Foods and Human Nutrition

489 Fortification in dairy products. C. Boeneke*, *Louisiana State University Agricultural Center, Baton Rouge.*

Webster's dictionary defines fortification as the act or process of adding materials to for strengthening or enriching. Fortification of dairy products is not a new idea. The process of fortification of milk with vitamin D dates back to the 1930's. The acceptance of this practice led to additions of vitamin A and minerals in the 1940's. No vitamin content levels were specified by the Milk Ordinance and Code until 1953 when a level of at least 400 International units (IU) per quart was established for vitamin D. In 1965, the Milk Ordinance and Code became the Grade A Pasteurized Milk Ordinance or PMO. This PMO defined low fat milk but gave no provisions for its fortification. An increase in consumption of the lower fat products led to nutritional concerns over vitamin A. The content of vitamin A, a fat-soluble vitamin, is smaller in the lower fat product. The 1978 PMO required fortification of these lower fat products at levels of not less than 2000 IU per quart for vitamin A. Vitamin D

fortification was still optional and could be added at 400 IU per quart. Consumers are demanding products that taste good and have health benefits. Dairy products are already rich in nutrients like potassium, riboflavin, calcium and vitamins A, D, and B-12. Fortification has the potential to improve them further. Dairy products fortified with added calcium, whey proteins, beneficial bacteria, and isoflavonoids are already on the shelves. Other ingredient additions such as vitamin C and E, lactoferrin, lutein, and others are available. Fortification poses unique problems to scientists and manufacturers involved with dairy products. Interactions with the ingredients used in fortification can cause product improvement or product detriment. More research must be conducted to examine the results of fortification in dairy products.

Key Words: Fortification, Dairy

490 Consumer attitudes toward dairy foods. C. M. Bruhn, *University of California, Davis.*

Taste is the number one reason for selecting food, but interest in nutritional content and special health benefits is also important. Consumers respond positively to the taste of many dairy products, but perceptions of health benefits are not as positive as they could be, perhaps because of the strong association of dairy with high fat. An increasing number of consumers are aware that food can provide special health promoting nutrients. Both traditional nutrients, like calcium, and nutrient components of emerging importance, like probiotics, can increase the appeal of dairy foods. Consumers are aware that dairy products help protect against osteoporosis, and many recognize that they do not get enough calcium, however young and middle aged people incorrectly believed they do not have to guard against this disease until they were older. People are not aware of other benefits of dairy products, such as the potential protection provided by calcium against certain cancers and lowering of blood pressure. Furthermore, people have not heard that diets that include dairy result in faster weight loss. While yogurt is generally perceived as a healthy product, consumers are not aware of the numerous potential benefits that probiotic cultures may provide. Although parents expect children to consume dairy product, modeling this behavior by parents is lacking in many home. Label statements may help alert consumers to a fuller range of dairy advantages. Promotion programs that emphasize the number of servings needed at each stage in the life cycle would provide information not generally known by the public today.

Key Words: Consumer, Calcium, Probiotic

491 Probiotics in health: Their immunomodulatory potential against allergic disorders. Z. Ustunol* and J. J. Pestka, *Michigan State University, East Lansing.*

Prevalence of allergic disease such as asthma, food allergies hay fever and eczema is rising with most rapid increases are observed in developed countries. In the U.S., today, one in every four children and one third of the adult population are reported to have allergies. Although the reason for this increase are not completely known, over the past 20 - 30 years changes in food processing, sanitation, disease eradication and extensive use of antibiotics have been suggest to have altered postnatal immune function and development favoring allergic immune profiles. While the primary reason for atopic diseases may be genetic susceptibility, gastrointestinal microflora is recognized to modulate the local immunological environment and influence systemic immunological events, thus, response to allergens. Probiotic ingestion may alter the gastrointestinal microflora by providing bacterial cells to this ecosystem and have been suggested as potential candidates for immunomodulation and for ameliorating allergic diseases. The major mechanism by which probiotics influence the immune system may relate to their ability to differentially modulate expression of cytokines and co-stimulatory molecules. Probiotic administration can also enhance IgA production, which is thought to be important in clearing of allergens. Although,

the etiology of allergies is complex and the exact mechanisms by which probiotics may affect these diseases are still speculative and mechanistic details are yet to be elucidated, probiotics are already being explored with increasing interest for their therapeutic potential in the management and even primary prevention of allergic disorders. Clinical and epidemiological studies indicate that probiotics potentially may be a viable option for management and prevention of allergies.

Key Words: Probiotics, Immune Modulation, Allergies

492 Nutritional properties of whey proteins. K. J. Burrington*, *Wisconsin Center for Dairy Research, Madison.*

Whey proteins have long been recognized for their functional properties and broad application in foods. Only recently, has interest developed in the nutritional properties of whey-derived food ingredients. Body builders were some of the first consumers to recognize the nutritional value of whey proteins as dietary supplements. Though the body builders' main interest is the muscle repair and building ability of the branched chain amino acids found in whey products, there are many other nutritional benefits associated with selected whey proteins. For example, alpha-lactalbumin, lactoferrin, glycomacropeptide and other whey peptides have been shown to manifest unique nutritional bioactivities. This presentation will review the current knowledge detailing the nutritional properties of whey proteins.

Key Words: Whey Proteins, Nutrition, Bioactivity, Peptides

493 The beneficial role of dairy foods on weight and body fat loss: Where we are and where we are going. D. B. DiRienzo*, *National Dairy Council, Rosemont, IL.*

Obesity has been classified as an epidemic in the U.S. A growing body of evidence indicates that dairy products may be part of the solution, not part of the problem for weight and body fat management. Several studies have indicated an inverse relationship between calcium/dairy product intake and weight/body fat in men, women and children. Animal and in-vitro studies have provided a plausible mechanism on how dairy foods may exert a beneficial effect. Clinical studies have demonstrated that the inclusion of at least three servings of milk, yogurt, or cheese per day can augment weight and body fat loss which occurs from reduced energy intake. Moreover, the impact of dairy foods is greater than calcium supplements or low calcium diets suggesting dairy foods contain additional components, beyond calcium, which impact weight. Additional research is underway or planned to further expand the beneficial impact of dairy foods on weight management. Industry and consumer communication efforts on this relationship have been initiated and expand in 2004 and 2005. This presentation will review the science and communication activities associated this newest benefit of consuming 3+ servings of milk, yogurt or cheese products per day.

Key Words: Dairy Products, Weight Management

Growth and Development: ADSA - Mammary Development - The Role of Progenitor Cells and Nutritional Modulation on Lactation

494 Bovine mammary progenitor cells. S. Ellis*, *Clemson University, Clemson, SC.*

Dairy profitability is dependent on the cyclic development and differentiation of the mammary gland. As in other somatic tissues, a resident population of mammary stem cells is thought to be responsible for supporting the development of the mammary parenchyma. While there is general agreement regarding the existence of mammary stem cells, little else about this important cell population is known. There is a particular lack of information about stem cells in the bovine mammary gland. Data from a number of experimental models suggest that mammary stem cells are scattered throughout the mammary parenchyma and are resistant to stimuli that would promote differentiation. Investigations of prepubertal mammosgenesis in heifers indicate that a histologically distinct population of lightly staining epithelial cells are the primary proliferative cell population in mammary parenchyma. The so-called

light cells have been described in mammary parenchyma of all species examined to date. Unfortunately, the nomenclature relating to these putative mammary stem cells is inconsistent and classification of the cell staining is very subjective. Much of the confusion around mammary stem cells relates to epithelial cells being mistaken for wandering lymphocytes and to the differences between progenitor cells and true stem cells. However, recent ultrastructural studies have clearly shown that light cells do indeed possess epithelial characteristics, and molecular analyses are beginning to identify potential markers that will help identify stem cells in situ. The application of refined embedding, microtomy, and staining techniques for histologic examination with the light microscope has helped to facilitate investigations of putative mammary stem cells, but the experiments are still time-consuming, relatively subjective, and difficult to perform on a large number of tissue samples. Critical needs for future studies of bovine mammary stem cell physiology include: the development of genomic and proteomic information for

bovine model systems; investigations of the ontogeny of mammary stem cell formation, activity, and senescence; and integration of in vitro, genomic, and proteomic information into histologic analyses of mammary development and function.

Key Words: Mammary Stem Cells, Mammogenesis

495 Characterization of gene expression patterns in bovine mammary epithelial cells isolated using laser capture microdissection. B.E. Etchebarne*, M. Kiupel, and M.J. VanDeHaar, *Michigan State University, East Lansing.*

Molecular examination of specific cell populations in primary tissues is necessary to elucidate the mechanisms underlying cellular responses to cytokine and hormonal signals. The inherent heterogeneity of tissues with varying mixtures of reactive cell populations can decrease the sensitivity and accuracy of molecular studies of gene expression. Technological advances in microdissection have allowed for the isolation of homogeneous, morphologically identified cell populations from prepared tissues. When used in conjunction with sensitive analytical techniques, such as quantitative reverse transcriptase polymerase chain reaction (qRT-PCR), microdissection allows precise in vivo examination of gene regulation within the cell population of interest. Using procedures developed in human breast cancer studies, we employed laser capture microdissection (LCM) to study the gene expression profile of epithelial cells in bovine mammary tissues treated with IGF-I and leptin. Our study was performed using frozen samples of bovine mammary parenchyma embedded in OCT compound and sectioned at 8 μ m. Following a brief hematoxylin staining and sequential dehydration, cell sections were air-dried and immediately isolated using the Arcturus Pix-Cell laser capture microscope. Using the SYBR Green-based detection method of qRT-PCR, transcripts for leptin receptor, beta-actin, and forkhead transcription factor FOXO3A were detected in as little as a 1:100 dilution of RNA (equivalent to 10 cells) isolated from a single LCM cap and subsequent cDNA synthesis. Ongoing studies are focusing on characterizing and quantifying relative gene expression between LCM versus whole tissue preparations of specific genes of interest for both epithelial and stromal bovine mammary cell populations.

Key Words: Laser Capture Microdissection, Gene Expression, Mammary

496 Phenotypic and ultrastructural characterization of the developmental pathway of bovine mammary gland progenitor cells. M. S. Holland*¹, L. D. Griffin¹, J. A. Stasko², and R. E. Holland*³, ¹*Veterinary Microbiology and Preventive Medicine, Iowa State University, Ames*, ²*National Animal Disease Center, USDA-ARS*, ³*Veterinary Diagnostic and Production Animal Medicine, Iowa State University.*

A model system that scaled down the mammary gland to its most essential components was developed. Bovine mammary gland progenitor cells (BMGPC) were isolated from the mammary parenchyma by biopsy and collagenase digestion. The isolation process confirmed the parenchyma as one site within the mammary gland that contained mammary stem/progenitor cells. Cell culture techniques were used to purify the BMGPC from other cell types in the mammary gland. Based on ultrastructural analysis, BMGPC were divided into two populations. An undifferentiated population exhibited minimal absorption of osmium tetroxide while the differentiated population exhibited efficient absorption of osmium tetroxide. The two populations also differed in the number and type of cellular organelles. Undifferentiated BMGPC had mitochondria and tonofilaments. Depending on the stage of differentiation, differentiated BMGPC contained mitochondria, tonofilaments, rough endoplasmic reticulum, free ribosomes, golgi apparatus, protein-filled vesicles, etc. The differentiation process in BMGPC appeared to be controlled by the complex cellular microenvironment as indicated by the response of BMGPC to signals from hormones and the extracellular matrix. Our results indicated that components in extracellular matrix elicited a range of responses. While matrigel induced undifferentiated BMGPC to differentiate, laminin, collagen I and IV induced minimal differentiation. Signals from hormones and growth factors were also key in inducing differentiation. In conclusion, we produced a cell line for functional studies of the mammary gland.

Key Words: Progenitor Cells, Differentiation, Ultrastructure

497 Effects of energy intake and time to puberty on mammary growth of prepubertal Holstein heifers. M. J. Meyer*¹, A. V. Capuco², and M. E. Van Amburgh¹, ¹*Cornell University, Ithaca, NY*, ²*USDA-ARS, Beltsville, MD.*

In the bovine, early postnatal mammary growth is thought to occur at an allometric rate and return to an isometric rate after puberty. Elevated energy intake prior to puberty has been shown to retard mammary parenchymal (PAR) DNA content at puberty, however, a causative relationship between PAR DNA at puberty and future milk yield has yet to be substantiated. Our objectives were to describe effects of increased energy intake from shortly after birth on 1) total PAR and fat pad (FP) DNA, 2) PAR DNA accretion rates, and 3) timing of the prepubertal allometric growth phase. Holstein heifers (n = 78) were fed from 45kg either elevated (E) or restricted (R) levels of energy to achieve divergent rates of gain (E 950 g/d; R 650 g/d). Six heifers per treatment (TRT) were slaughtered at 50kg increments from 100 to 350kg. Six were slaughtered at 46kg, at which time PAR was difficult to discern and present as a small cord of tissue. FP weights were similar between TRT up to 200kg but were heavier from 250 through 350kg in E-heifers (P < 0.05). However, FP DNA content was similar between TRT until 350kg, at which point FP DNA was greater in E- than R-heifers (P < 0.05). PAR DNA was similar between TRT up to 200kg. From 250 through 350kg, R- had more PAR DNA than E-heifers (P < 0.05). Interestingly, daily PAR DNA accretion rates, calculated between consecutive slaughter points, were not influenced by energy intake (P = 0.98). This rate reached a peak of 5.4 mg PAR DNA per day between 200 and 250kg and declined precipitously during the peripubescent period. A plot of the log BW vs. log PAR DNA indicates that mammary growth rate, independent of TRT, was allometric by 100kg BW and became isometric shortly before puberty (puberty occurred at 280kg independent of TRT). These data demonstrate that reductions in mammary PAR DNA associated with elevated rates of gain result from a reduction in time to puberty rather than impairment of epithelial cell proliferation and PAR DNA accretion.

Key Words: Heifer, Mammary Development, Puberty

498 Nutritionally directed compensatory growth affects mammary cell proliferation and apoptosis. C. S. Park*, *North Dakota State University, Fargo.*

The proper application of a time-dependent and closely controlled nutrition regimen during different growth stages prior to first parturition can affect mammary development and subsequent lactation potential. We have developed a compensatory growth nutrition regimen which is a combination of dietary energy restriction and realimentation phases designed to regulate mammary development. The basic concept of this nutrition regimen is to exploit the biological nature of the energy restriction and compensatory growth phenomenon in concert with one or more hormone-sensitive allometric phases of mammary development (i.e., peripuberty through gestation). We have examined various models for developing dairy and beef heifers, gilts, and rats. General observations are that compensatory growth regimens have positive effects on mammogenesis and lifetime lactation performance. The synergistic interaction of nutritionally induced compensatory mammary growth with developmentally related allometric growth causes a cascade of up-regulation of various genes which affect cellular activity and regulate the cell cycle. Compensatory growth causes permanent hyperplasia and hypertrophy of mammary alveolar epithelial cells, thereby stimulating mammary development and differentiation as evidenced by increased expression of ornithine decarboxylase and β -casein. The decrease in epithelial cell death in compensatory mammary tissue may be closely related to an increase in the expression of insulin-like growth factor-I which affects both cell cycle progression and apoptosis. Our recent studies with expression profiling by gene array analysis reveal that compensatory mammary growth modulates genes associated with a broad range of metabolic pathways or physiological functions (i.e., proliferation, differentiation, secretion, cellular communication, apoptosis, lipogenic and myogenic pathways, and tissue remodeling). By altering the expression of cell cycle genes, compensatory mammary growth provides a potential means to manipulate mammary function and lactation.

Key Words: Compensatory Growth, Mammary Cell Proliferation, Apoptosis

499 Effects of a high rate of gain for increasing lengths of time on body and mammary growth in prepubertal dairy heifers. L. E. Davis*, M. S. Weber Nielsen, L. T. Chapin, J. S. Liesman, and M. J. VandeHaar, *Michigan State University, East Lansing.*

A high rate of gain in dairy heifers for #8805 3 mo is detrimental to prepubertal mammary growth and subsequent milk yield. However, the effects of a high rate of gain for shorter periods have not been reported. Our objective was to compare effects of high (1200 g/d) and low (600 g/d) rates of gain over different lengths of time (0, 3, 6, 12 wk) on body and mammary growth. Heifers (age = 11 wk, n = 64, BW = 107 kg, SE = 1.0) were randomly assigned to 1 of 4 treatments: H0 (low diet fed for 12 wk); H3 (low diet fed for 9 wk followed by high diet for 3 wk); H6 (low diet fed for 6 wk followed by high diet for 6 wk); and H12 (high diet fed for 12 wk). Animals were slaughtered at 23 wk of age. Statistical analysis used the GLM procedure of SAS and tested multiple comparisons using the Bonferroni test. Statistical significance was declared at $P < 0.05$. Average daily gain and final live weights were different for all comparisons except H0 versus H3 (H0 = 662, H3 = 660, H6 = 848, H12 = 1124 g/d, SE = 12; H0 = 165, H3 = 166, H6 = 181, H12 = 203 kg, SE = 1). Final withers height was greater for H6 and H12 (H0 = 100, H3 = 100, H6 = 102, H12 = 104 cm; SE = 0.3). Carcass wt were different for all comparisons (H0 = 77, H3 = 82, H6 = 92, H12 = 107 kg; SE = 1). Mammary hemigland mass increased with time on high diet (H0 = 529, H3 = 591, H6 = 768, H12 = 864 g/100 kg carcass wt; SE = 43). Mass of perirenal fat also increased with time on the high diet (H0 = 900, H3 = 1181, H6 = 1608, H12 = 1794 g/100 kg carcass wt; SE = 105). Short-term changes in diet altered growth of body and mammary tissues. Composition analysis of carcass and mammary tissues are ongoing.

Key Words: Growth, Heifer, Mammary

500 Long days that hasten puberty do not reduce lean body growth in heifers. A. G. Rius*¹, P. E. Kendall¹, T. L. Auchtung¹, A. V. Capuco², E. E. Connor², and G. E. Dahl¹, ¹*University of Illinois, Urbana,* ²*USDA-ARS, BGFL, Beltsville, MD.*

Photoperiod affects growth and development in many species with long day photoperiod (LDPP; 16L:8D) hastening the onset of puberty and enhancing lean growth in cattle. Appropriate body scale is crucial in heifers at first parturition. However, accelerating prepubertal growth may diminish mammary parenchymal growth. Nutritional factors including metabolizable protein also affect the onset of puberty, body and mammary growth in heifers. Our objective was to determine if LDPP hastens the onset of puberty without limiting skeletal growth, (i.e. height). We also sought to determine if the response to LDPP is limited by protein availability. Holstein heifers (n = 32) were assigned to 1 of 4 treatments in a randomized complete block design and a 2x2 factorial arrangement to assess effects of photoperiod and dietary bypass protein on the onset of puberty and body growth. Treatments were LDPP, short day photoperiod (SDPP; 8L:16D), high or low dietary bypass protein. Blood samples were analyzed for PRL concentration to confirm a photoperiodic response and for progesterone to determine puberty. Body weight (BW), withers height (WH), hip height (HH), and heart girth (HG) were measured every two weeks. After puberty, heifers were housed under natural photoperiod and body measurements were continued to evaluate body growth postpubertally. Heifers exposed to LDPP reached ($P < 0.02$) puberty 20 d earlier than animals on SDPP. Increasing dietary bypass protein did not affect growth of heifers (BW, WH, HH or HG) on either photoperiod treatment. However, heifers previously exposed to SDPP gained 22 kg more ($P < 0.05$) of BW after puberty than did heifers previously exposed to LDPP. These data support the use of photoperiod as a non-invasive technique to hasten skeletal without limiting lean growth and development in heifers.

Key Words: Photoperiod, Growth, Heifer

PSA World Poultry Science Lecture

501 Reducing the carriage of foodborne pathogens by livestock and poultry. M. P. Doyle*, *Center for Food Safety, University of Georgia, Athens.*

Livestock and poultry are frequently asymptomatic carriers of human enteric pathogens. Salmonella, Campylobacter and Escherichia coli O157:H7 can reside in the animal's gastrointestinal tract and be shed in feces that subsequently contaminates food and water. Practical, effective on-farm interventions are needed to provide greater protection of the environment and the food supply. Progress is being made on several

fronts in developing useful strategies for pathogen control in animals. Examples include competitive exclusion microorganisms, vaccines, bacteriophages, water/feed treatments, and husbandry practices. Reducing pathogen carriage by animals on the farm can have a major impact on reducing contamination of the environment, water and food, thereby providing greater public health protection.

Key Words: Foodborne Pathogens, Competitive Exclusion, Preharvest Interventions

Animal Behavior & Well Being II

502 Correlating spatial learning, social recognition and aggression in young pigs. J. M. Siegford*, A. S. Souza, J. Jansen, and A. J. Zanella, *Department of Animal Science, Michigan State University, East Lansing.*

We examined cognitive abilities and agonistic behavior in young female pigs to determine whether spatial learning (SL) was correlated with social recognition (SR) and post-mixing aggression. SL and SR require activation of the hippocampus, thus they may be correlated. Therefore, pigs performing well in SL should remember other pigs more easily in SR and might use information of previous social encounters to avoid fights when mixed. SL of pigs was tested twice (d13 and d14) using a modified water maze (WM) in which pigs in a pool of opaque water locate a submerged platform (5 exposures per pig separated by 10min). Good (GP; n=23) and poor performers (PP; n=24) were selected based on latencies from previous WM results for pigs of this age. Using average latencies from exposures 2-5 on both days, criterion for GP was <55s and criterion for PP was >70s. Animals were familiarized at d20 and d21 in arenas divided by flexible netting. SR testing was subsequently carried out at d21 and d22. At d23, all pigs were weaned. On d24, piglets were retested in the WM. Latency continued to decrease, suggesting weaning did not disrupt memory of the WM task, but no difference in latency was seen between GP and PP ($F_{1,47}=0.04$; $p=0.84$). At d25, pigs were mixed in groups of 6 GPs (n=4) or PPs (n=4) and duration and number of fights were monitored for 1 day. Pre-mixing familiarization led to a decrease

in post-mixing fights ($F_{1,43}=4.75$; $p=0.03$; 7.26 ± 1.49 vs. 4.46 ± 0.69). In the first 3 hours post-mixing, unfamiliar PPs fought more than other groups ($F_{1,43}=14.33$; $p < 0.001$; 13.67 ± 2.32 vs. 5.22 ± 2.22), suggesting a correlation between SL and post-mixing aggression. Duration of fights was affected by interaction of day with familiarity ($F_{1,43}=4.61$; $p=0.04$) and time of day with WM performance ($F_{1,43}=4.41$; $p=0.04$). Additional animals are being tested to strengthen findings, which suggest familiar pigs and possibly GP fight less. Protocols could be developed to familiarize litters to reduce post-mixing aggression in production.

Key Words: Behavior, Welfare, Learning

503 Acute stress impairs spatial learning and social recognition in early-weaned pigs. A. S. Souza*, K. Laughlin, J. M. Siegford, and A. J. Zanella, *Department of Animal Science, Michigan State University, East Lansing.*

We investigated whether weaning age and social isolation disrupt spatial learning (SL) and/or social recognition (SR) in newly-weaned pigs. Female pigs were early-weaned at d11-12 (EW; n=48) or conventional-weaned at d23 (CW; n=48) and social isolation (SI) for 15 minutes occurred immediately before testing each pig once in either SL or SR. We assessed SL using a modified water maze, in which pigs in a pool of opaque water and must locate a submerged platform. The latency to reach the platform from a pre-determined release point was recorded

over 7 exposures (separated by 10 minutes). A decrease in latency across exposures has been validated as a measure of SL. For SR, 2 litters at time were habituated to each other for 8h in an arena divided by netting, preventing mixing and fighting. The day following habituation pairs of pigs from habituated litters were re-habituated for 20min, then pigs were exposed to a familiar or an unfamiliar conspecific for 3min to test SR. Duration of social investigation is a valid measure of SR as familiar conspecifics spend less time in social investigation than unfamiliar animals. Social isolation of pigs caused significant impairment in SL (GLM; $F_{1,48}=18.59$, $p=0.0001$) and interaction of weaning age and SI (GLM; $F_{1,48}=11.14$, $p<0.0018$), with EW pigs showing no decrease in latency following isolation. A significant interaction existed between weaning age and SI during SR between familiar animals (GLM; $F_{1,17}=23.13$, $p=0.0002$). Socially isolated EW pigs investigated familiar animals more than non-SI EW animals ($66.57s\pm 5.92$ vs. $14.28s\pm 3.54$, $p<0.0001$), SI CW ($18.60s\pm 5.92$, $p<0.0001$) or non-SI ($20.80s\pm 7.26$, $p<0.0001$) CW pigs. The amount of social investigation did not differ in unfamiliar animals. The observed deficits in SL and SR with EW and SI suggest potential cognitive disruption and may be affected by age at which the developing brain is exposed to increases in stress hormones, such as those accompanying weaning. Possible neural mechanisms for this disruption are being investigated.

Key Words: Welfare, Behavior, Stress

504 Relationships among pre- and post-weaning oral-nasal behaviors and growth rates in newly weaned pigs. S. Torrey* and T. M. Widowski, *Department of Animal and Poultry Sciences, University of Guelph, Guelph, ON, Canada.*

Previous studies have found large differences in the amounts of time that individual piglets spend belly-nosing in the first few weeks post weaning, but the individual characteristics that predispose some pigs to perform oral vices are not known. The objectives of this experiment were to discern whether piglets that perform the most nursing behaviors during and in-between nursing bouts pre-weaning also perform the most belly-nosing and pig-directed behaviors post-weaning and to determine any relationships between these behaviors and growth rates. Sixty-six pigs from seven litters of Yorkshire pigs were individually identified and observed for nursing-related behaviors during and in between three nursing bouts on each of three days pre-weaning (days 7, 12, 17 of age) and weaned at 21 days. Pigs were penned with littermates post-weaning and behaviors were scan sampled from video-recordings for 21 days. In addition, individual piglets were weighed at birth, at days 7, 12 and 17 of age, at weaning and at days 7, 14 and 21 post-weaning. Pearson partial correlations were performed on individual pig data with litter used as a partial covariate. The performance of nursing behaviors during a nursing bout tended to be negatively related to belly-nosing post-weaning ($P = 0.07$; $r^2 = -0.22$). Birth weight ($P < 0.05$; $r^2 = -0.26$) and post-weaning average daily gain ($P < 0.01$; $r^2 = -0.35$) were also negatively related to belly-nosing. Alternatively, there were positive relationships between nosing behavior directed onto objects post-weaning and pre-weaning ($P < 0.001$; $r^2 = 0.45$) and post-weaning ($P < 0.05$; $r^2 = 0.29$) average daily gains. Pre-weaning behaviors and growth rates are related to the performance of oral-nasal behaviors post-weaning, with the low birth weight, slower-growing piglets performing the most belly-nosing.

Key Words: Belly-Nosing, Nursing, Weaning

505 Effects of induced mixing and pen size on performance and serum concentration of acute phase proteins in growing pigs. C Piñero*¹, J Morales¹, M Piñero*¹, F Lampreave², and G.G Mateos³, ¹PigCHAMP Pro Europa, S.A., Spain, ²U. de Zaragoza, Spain, ³UP. de Madrid, Spain.

There is a growing interest to assess the response to stressors in pigs. The objective of this study was to determine the response of serum levels of two acute-phase proteins (APP's) (Pig-MAP; MAP and haptoglobin; HPT) and performance due to mixing and pen size at the entry at the fattening unit. A total of 240 pigs (LW x LW-LD) 20.2 ± 0.9 kg BW was randomly distributed in 24 pens in a $2 \times 2 \times 2$ factorial that included the effects of mixing (mixing or same piglets than in nursery), pen size (8 or 12 pigs per pen), and sex. Piglets were controlled every 14 d from 60 to 116 d of age to determine ADG, FC and FI). Blood samples were taken at d 1, 5, 14, 28, and 42 d of the study. Mixing affected APP's concentration. The day following placement at the fattening barn, mixed pigs had higher MAP values (2.07 vs 1.36 mg/mL;

$P=0.0006$) than not-mixed pigs and the differences were still significant 5 d after placement (1.18 vs 0.90 mg/mL; $P=0.04$). At d 14, mixed pigs tended to have higher MAP values (0.69 vs 0.54 mg/mL; $P=0.07$) than non-mixed pigs but the difference disappeared thereafter. No consistent pattern was observed for HPT, but the concentration was always higher for mixed pigs and in fact the effect was significant at d 14 (1.83 vs 1.31 mg/mL; $P=0.05$). The differences in APP's concentrations correlated with differences in productive performance and from 74 to 88 d of life non-mixed pigs showed a higher ADG than mixed pigs (667 vs 624 g/d; $P=0.02$). Pen size did not have any effect on APP serum concentrations but ADG were higher for pigs kept in groups of 8 than in pigs kept in groups of 12 (736 vs 712 g/d; $P=0.03$, respectively). Boars were more sensitive to both stressors than females and showed higher MAP concentration ($P<0.05$) and lower growth ($P<0.05$) than females. We conclude that mixing of pigs at the start of the fattening period induces stress independently of pen size and that serum concentration of APP's can be used to detect the intensity of the stress.

Key Words: Pigs, Stress, Acute-Phase Proteins

506 Gestation induced changes in behavior and autonomic regulation of cardiac activity in gilts. R. M. Marchant-Forde* and J. N. Marchant-Forde, *USDA-ARS, West Lafayette, IN.*

Gestation in mammals is a time of considerable physical, physiological and behavioral change necessary for the continuance of the pregnancy. Gestating pigs are often used in behavior and well-being studies yet there is little published data describing how gestation affects normal behaviour and patterns of autonomic regulatory control of cardiac activity. The objective of this work was to evaluate gestation induced modifications in the longitudinal dynamics of behavior and autonomic regulation of cardiac activity using heart rate variability parameters in primiparous pigs. The behavior and cardiac activity of ten gilts were recorded at fixed time points over gestation as follows: 1 weeks before oestrus and mating (week 1), 14 days post-mating (week 2), day 30 (week 4), day 44 (week 6), day 65 (week 9), day 79 (week 11), day 93 (week 13) and day 107 (week 15) of pregnancy. Temporal changes in behavior patterns were present in all gilts over the course of gestation. Pre-test levels of general activity progressively declined between weeks -1 and 15 as indicated by a decrease in the proportion of observations spent rooting ($p<0.001$), walking ($p<0.001$) and standing ($p<0.001$). There was a corresponding increase in inactivity ($p<0.001$) and the proportion of time spent sleeping, as opposed to lying alert, increased also ($p<0.001$). Apart from RR-min and its corresponding HR-max indices, all time domain parameters of cardiac activity were substantially influenced by stage of gestation. Specifically, mean HR increased ($p<0.001$) whereas RMSSD and SD decreased ($p<0.001$). Pregnancy further impacted on frequency domain measures of heart rate variability. From week 1 to week 15 the absolute magnitude of Total power ($p<0.001$) decreased, HF power decreased, ($p<0.001$) and LF power increased ($p=0.004$). In conclusion, pregnancy induced widespread changes in behavior and in sympathovagal regulation of cardiac activity in pigs that were reflected in both time and frequency domain indices of heart rate variability analysis.

Key Words: Gestation, Behavior, Heart Rate Variability

507 Circadian rhythmicity in behaviour and cardiac activity of gilts and heifers. R. M. Marchant-Forde*¹, J. N. Marchant-Forde*¹, and R. Hofman², ¹USDA-ARS, West Lafayette, IN, ²Institute of Animal Husbandry and Welfare, University of Veterinary Medicine, Vienna, Austria.

Biological rhythms are of universal occurrence in animals and it is usually easy to demonstrate adaptive explanations for them. The aim of this work was to examine circadian patterns of behavior and cardiac activity in gilts and heifers, to determine if any rhythms present followed general sleep/wake cycles and the degree to which they were influenced by activity levels. Continuous behavior and cardiac data were simultaneously recorded in non-gravid gilts and heifers over a 24h period. Scan sample were used to extract behavior data from videotapes and hourly means for all behaviors, as well as the proportion of time spent active or inactive, were determined. Cardiac data was processed for error before undergoing heart rate variability (HRV) analysis. Hourly means for all cardiac indices were also calculated. Cosinor analysis was used to evaluate circadian rhythms from which the MESOR, amplitude, acrophase, and Pearsons correlation coefficient were determined. Results

found that gilts and heifers differed largely in their 24h behavioral time budgets. Heifers were considerably more active ($p < 0.01$), spent more time standing ($p < 0.01$) and less time investigating their surroundings ($p < 0.01$) than gilts. Gilts showed more circadian rhythmicity in behavior and HRV indices than heifers. Circadian patterns in time domain indices were generally similar, but with gilts demonstrating higher correlation coefficients than heifers in all bar one parameter. Relative to the sleep/wake cycle, rhythms in cardiac activity in gilts were closely associated with the sleep/wake cycle with mean HR being highest and parasympathetic indicators lowest at the end of the sleep period. While heifers demonstrated little circadian rhythmicity in behavior, rhythms in cardiac activity followed obvious circadian patterns, though their rhythmicity was still considerable lower than those in gilts. In summary, gilts showed strong circadian patterns in behavioral and HRV parameters, which were strongly interrelated, whereas heifers showed much weaker evidence of behavioral circadian patterns, but exhibited surprisingly strong circadian rhythmicity in HRV measures.

Key Words: Circadian Rhythms, Behavior, Heart Rate Variability

508 Behavior and heart rate of crated gestating sows given an ICV CRH or a CRH receptor antagonist. L. E. Hulbert^{*1}, J. M. Hellman¹, J. W. Dailey², J. L. Morrow², and J. J. McGlone¹, ¹*Pork Industry Institute, Texas Tech University, Lubbock*, ²*USDA-ARS, Livestock Issues Research Unit, Lubbock, TX*.

Third-parity, crated Camborough-28 (PIC USA) sows ($n=3$) were used to determine the effects of intracerebroventricular (icv) corticotropin releasing hormone (CRH) or a CRH antagonist (Astressin, AST) on sow behavior and heart rate. Specifically, we sought to determine if oral-nasal-facial (ONF) stereotyped behaviors were caused by elevations in central CRH. Sows were surgically fit with an icv canulae in the lateral ventricle during mid gestation. Following an 8-d recovery period, sows were fed and then 30 min later given icv saline (SAL), CRH or AST. Heart rates (Polar 610 IR) and sow behavior were recorded for 48 h after icv injection. Behaviors included sitting, standing, feeding, drinking, sham chewing, ONF directed towards the bars, floor, or feeder and total ONF duration and frequency. Central CRH increased ($P < 0.01$) ONF directed towards the bars and the floor and total ONF compared with icv SAL. AST did not ($P > 0.10$) change ONF or general activity. Total ONF duration was 187.8, 2,253.1 and 203.1 s for SAL, CRH and AST, respectively ($P < 0.001$; SE = 117.8). Lying down duration was lower for CRH-treated sows than for sows in the other treatments (3,261, 1,153, 3,175 s for SAL, CRH and AST, respectively, $P < 0.001$; SE = 127). Heart rate was increased among CRH-treated sows compared with the other treatment groups (75, 114 and 86 bpm; $P < 0.01$; SE = 5.8). Increasing central CRH dramatically increased ONF, general activity and heart rate. Central AST did not reduce (or increase) ONF or heart rate. We conclude that elevated basal levels of CRH among crated sows does not cause ONF behaviors (because AST did not reduce this behavior). However, elevated central CRH increases both ONF behaviors and heart rate. Sow bar-biting behaviors, at the levels observed in crated sows, is not caused by elevated central CRH.

Key Words: Pigs, CRH, Welfare

509 Behavioural description of cannibalism in fattening pig production. D. Saffray^{*1}, I. Madec¹, C. Lafont¹, J.-F. Gabarrou², and P. Pageat¹, ¹*Pherosynthese, Saint Saturnin d'Apt, France*, ²*ESA-Purpan, Toulouse, France*.

Cannibalism in fattening pigs' production refers to a special behavioural problem characterised by repeated bites between pen-mates, leading to wounds of variable severity. Stress and infections following these bites generate decrease of growth rate, emergency slaughter and carcass rejection at the abattoir. Cannibalism is at once a health, welfare and economic problem. Many solutions have been suggested but treatments showed a variable efficiency. A major reason of this situation is that the true causes of cannibalism are still unknown. To find out these causes, an accurate behavioural description is essential to establish if different types of individuals with particular behavioural patterns exist. From a list of 137 pig farms with cannibalism historical records, 12 farms were selected. Inclusion criteria were type of production, performance, genetic, type of cannibalism, type of buildings, feeding parameters, breeding methods and health status. Consequently, the selected farms were similar, allowing the constitution of a single database, with enough data for statistical analysis. In each pig farm, 2 to 4 pens were

filmed. For each pen, we realized 2 sequences of 30 minutes of video recording. Video recordings were analysed by means of a reading grid, focused on the bite act. We recorded wound status, bite type, motor act before the bite and motor act after the bite (for both the biter and the victim). With the resulting database, we carried out both a single variable descriptive analysis and a Multiple Correspondence Analysis. The part of the population involved in at least one bite is substantial (70 %) and is divided into four categories of individuals: biters who bite different body parts, biters who always bite the same body part, victims showing loss of tissue and individuals who are both biter and victim. Depending on the fattening pen in question, all or some of these categories are present, leading to suppose that we observed either different types of disorders or different stages of the same disorder. To settle this point, we need to carry out a study on cannibalism evolution in a same pen.

Key Words: Cannibalism, Description, Pig

510 Maternal pheromone application before and(or) after weaning: effects on pig behavior and performance. N. Krebs^{*} and J. J. McGlone, *Pork Industry Institute, Texas Tech University, Lubbock*.

Weaning is a stressful event for piglets. A synthetic maternal pheromone was studied to determine its effects on behavior and performance of groups of weaned piglets when applied either before and(or) after weaning. Ninety-six 4-wk-old piglets from 30 litters were randomly assigned to 4 treatments arranged factorially with pheromone (PH) treatment (1 mL per pig Suiience; Ceva Sante Animale) or control (CO) in the pre-weaning farrowing environment and PH treatment (1 mL) or CO in the nursery. Each block contained 32 pigs (1 castrated male and 1 female from 4 litters per treatment). Observers recorded live pig behavior pre-weaning using a 10-min scan sample for 40 min before treatment and 80-min after treatment. Prior to weaning, Suiience was applied on sows' teats (or not), to test the hypothesis that the maternal pheromone may increase teat-contact behavior and post weaning feeding behavior. Pigs were weaned into pens that contained either nothing or the maternal pheromone while being video taped in time lapse for 48 h. Pigs were weighed at weaning and each week for 4 wk. Feed disappearance was recorded and feed efficiency was calculated. The maternal pheromone applied in farrowing environment decreased piglet-teat contact behavior (16.2 vs. 8.5 %, SE = 1.91, $P = 0.047$, for CO and PH, respectively). The farrowing treatment by period effect was significant ($P = 0.03$) for post-weaning agonistic behavior; CO pigs had higher % time engaged in agonistic behavior than PH pigs during the first 8 h and 20 to 24 h after weaning. Pigs given PH in the nursery environment had a higher ($P = 0.02$) % of observations standing close to the feeder than CO piglets. There were no significant differences among treatments in pig weaning weights, post-weaning gain or feed intake. In conclusion, the application of PH on the sows' teats before weaning did not increase piglet-teat contact but PH reduced post-weaning agonistic behaviors and increased piglet time spent near the feeder.

Key Words: Pigs, Pheromone, Behavior

511 Pig behavioral responses to biologically relevant and non-relevant odors. N. Krebs^{*} and J. J. McGlone, *Pork Industry Institute, Texas Tech University, Lubbock*.

Pigs use olfaction to detect biologically-relevant odors including pheromones. The objective of this study was to quantify pig behavioral responses to biologically-relevant and non-relevant odors. Pigs were evaluated for their behavioral type. High responder pigs (HR) showed 3 or more escapes in a back test; low responder (LR) piglets showed 2 or less escape attempts in a back test; medium responders (MR) were not consistently LR or HR. Sixty 14-d old piglets (30 castrated males and 30 females) were assigned to randomly experience one odor treatment (isopropyl alcohol [ISO], n-butanol [NB], amyl acetate [AA], maternal feces [MF], synthetic maternal pheromone [MP] and the boar pheromone androstenone [AN]) with the odor applied once in liquid and once in aerosol form. The aerosol was out of reach of the pigs' touch. Piglets displayed the same behaviors regardless of the form of the odors (liquid or aerosol). Piglets oriented their snout away from AA compared to ISO ($P = 0.04$). There was a treatment by back test effect ($P < 0.01$) for lying behavior (indicator of general activity), parallel-facing the fan (PFF; $P < 0.01$) and parallel orienting away from the odor source (PAF; $P < 0.01$). MR pigs spent more time lying down

when experiencing MP than all other treatments. LR pigs did not differ in lying time among odor treatments. HR piglets exposed to AA, NB or MF had decreased lying time compared with ISO. MR pigs spent more time PFF (interested in the odor) when exposed to MF or NB compared with ISO. LR pigs showed similar PFF when exposed to each odor. HR piglets showed more PFF when exposed to MF than ISO. MR piglets showed more PAF (avoided the odor) when exposed to MP and AA than ISO-exposed piglets. LR and HR did not differ in their PAF behaviors among odors. These experiments demonstrated that pig behavioral type interacted with piglet behavioral responses to relevant and non-relevant biological odors.

Key Words: Pigs, Odors, Backtest

512 Effects of mixing stress on plasma cortisol, corticosteroid-binding globulin and free cortisol index in prenatally-stressed pigs. D. C. Lay Jr^{*1}, H. G. Kattesh², M. P. Roberts², M. J. Toscano¹, and K. A. McMunn¹, ¹USDA-ARS Livestock Behavior Research Unit, West Lafayette, IN, ²University of Tennessee, Knoxville.

Exposing a pregnant sow to stress has been shown to have negative effects on her resulting offspring. However, little knowledge exists regarding the mechanisms of this process or the effects of specific stressful events. Our objective was to determine if exposing a sow to stress altered the response of her offspring to mixing stress at 4 mo of age. Sow

treatments consisted of i.v. injections of adrenocorticotrophin (ACTH, 1 IU/kg BW) (ACTH), exposure to rough handling for a 10-minute duration (ROU), or no treatment (CONT) once a week during d 42 to 77 of gestation. At 4 mo of age, one pig from each litter (n = 14, 14, 15) was taken from its home pen and placed in a pen of unfamiliar pigs. Blood samples were collected three times per week for two weeks and then once a week for four more weeks. Blood samples were analyzed for cortisol and corticosteroid-binding globulin (CBG), and a free cortisol index (FCI; total cortisol/CBG) was calculated. In response to treatments, ACTH sows had greater concentrations of cortisol than did ROU sows, which had greater concentrations than CONT sows (77.1, 46.0 and 32.1 ng/mL, P < .004). CBG concentrations in pigs from CONT sows tended to be lower (P < .06) than pigs from ROU sows and was lower (P < .008) than pigs from ACTH sows (4.75 ± .10, 5.2 ± .12, and 5.51 ± .13 mg/L, respectively). An effect of gender was also detected with females having greater (P < .001) concentrations of CBG than males. No treatment differences (P < .10) were found for either plasma cortisol concentrations or FCI. A treatment by repetition (P < .02) and repetition effect (P < .04) were noted for both plasma cortisol and FCI. Prenatal stress, induced either artificially with injections of ACTH, or via rough handling, changes CBG responses compared to controls but does not alter either FCI or plasma cortisol concentrations. The degree to which effects of prenatal stress are induced in production livestock needs to be sought.

Key Words: Swine, Prenatal Stress, Corticosteroid Binding Globulin

Animal Health: Dairy Cattle Health – Transition Cows and Mastitis

513 Negative energy balance during the periparturient period is associated with uterine health disorders and fever in Holstein cows. D. S. Hammon^{*1}, I. M. Evjen¹, T. R. Dhiman¹, and J. P. Goff², ¹Utah State University, Logan, ²USDA, National Animal Disease Center, Ames, IA.

Eighty-three multiparous Holstein cows were used to investigate the association between periparturient energy balance and uterine health disorders and fever. Blood samples were collected weekly from wk -2 to wk 5 postpartum for serum nonesterified fatty acids (NEFA) and Beta-hydroxybutyrate (BHB) Feed dry matter intake (DMI) was determined daily from wk -2 to wk 5 postpartum. Cows were examined at wk 3 for clinical endometritis (purulent cervical discharge on vaginal examination) and at wk 4 for subclinical (SC) endometritis (presence of neutrophils on endometrial cytological exam). Retained placentae (RP) were determined by visual and vaginal speculum examination on d 1 postpartum. Rectal temperatures were recorded from day 1-10 postpartum. Fever was defined as a rectal temperature #8805103°F for #88052 d. Differences in measurements were determined using a repeated measures of ANOVA. Of 83 cows total, 14 developed RP, 13 developed clinical endometritis, 61 developed SC endometritis, and 18 developed fever. Cows with RP had significantly (P < 0.001) lower DMI beginning 1 wk before calving and for the first 3 wk of lactation compared to cows without RP. Cows with SC endometritis had significantly (P = 0.01) lower DMI from wk -1 to wk 5, significantly (P = 0.01) higher NEFA from wk -2 to wk 4, and significantly higher (P < 0.04) BHBA from wk 1 to wk 4, compared to cows without subclinical endometritis. Cows with fever had significantly (P = 0.05) lower DMI from wk 1 to wk 4, significantly (P = 0.03) higher NEFA from wk -1 to wk 4, and significantly (P < 0.03) higher BHBA wk 1 to wk 4, compared to cows without fever. DMI, NEFA, and BHBA were similar for cows with or without clinical endometritis. From these data, we suggest that some uterine health disorders and fever are preceded by negative energy balance that begins prior to calving and extends into early lactation.

Key Words: Periparturient Dairy Cow, Endometritis, Negative Energy Balance

514 The relationship between the incidence of production-limiting disease and return over feed in Ontario dairy herds. C. McLaren^{*1}, K. Lissimore¹, T. Duffield¹, K. Leslie¹, D. Kelton¹, and B. Grexton², ¹Department of Population Medicine, University of Guelph, Guelph, ON, Canada, ²Ontario Dairy Herd Improvement Corporation, Ontario, Canada.

Production-limiting diseases are some of the most prevalent and costly conditions in the dairy industry. Displaced abomasum (DA), retained

placenta (RP), lameness, milk fever, mastitis and ketosis have a large economic impact on the individual animal. However, there are few studies that quantify their effect on herd economics. The objectives of this research were to examine the relationship between profitability as measured by the Ontario Dairy Herd Improvement (DHI) Corporation's Return over Feed herd profit index (ROF), and production-limiting disease. Clinical disease incidence risk of DA, lameness, RP, milk fever, mastitis and ketosis were calculated from participant submissions. For the determination of subclinical mastitis and ketosis cumulative incidence, the California Mastitis Test (>0) and the KetoTest[®] Beta-hydroxybutyrate (greater than or equal to 100 umol/l) milk test were used weekly in early postpartum cows (1-14 days). Producers were identified through the Ontario DHI Corporation ROF groups. The ROF was calculated from the difference between milk revenue and feed cost each month. Feed cost was determined from herd level dry matter intakes at each operation multiplied by fixed market prices for each feed ingredient. Revenue was calculated based on the Dairy Farmers of Ontario multiple component pricing formula for milk. There were 48 producers that submitted ROF, postpartum monitoring and clinical disease data for the period January 1st, 2002 and January 31st, 2003. Using linear regression modeling, no significant association (p>0.05) was detected for subclinical and clinical mastitis, RP, lameness and milk fever herd incidence with ROF.

Disease	Mean Herd	Coefficient ¹	p-value
	Incidence Risk (%)	(\$/cow/day)	
Subclinical Ketosis	61.0	-0.015	0.0239
Clinical Ketosis	2.1	0.12	0.0030
DA	3.4	0.11	0.0085

¹Baseline ROF (Intercept)=\$13.13/cow/day, r²=0.33

Key Words: Return Over Feed, Production-Limiting Disease

515 An evaluation of rumen-protected choline and monensin controlled release capsule on milk production, health and metabolic function of periparturient dairy cows. L. Zahra^{*1}, S. LeBlanc¹, K. Leslie¹, T. Duffield¹, T. Overton², and D. Putnam³, ¹Department of Population Medicine, University of Guelph, Guelph, ON, Canada, ²Department of Animal Science, Cornell University, Ithaca, NY, ³Balchem Corporation, New Hampton, NY.

Three weeks prior calving, 185 Holstein cows were randomly assigned to receive one of the following: a monensin CRC, a daily top-dress of

56g rumen-protected choline (RPC; Reashure choline, Balchem Encapsulates, New Hampton, NY) until 28 days post-calving, both supplements (RPC+CRC), or neither (CON). Blood samples were collected at enrollment, one week pre-calving, and in the first and second weeks post-calving. Daily DMI from enrollment until 30 DIM, and daily milk weights up to 60 DIM were measured. Adjusting for parity and BCS at enrollment, beta-hydroxybutyric acid (BHBA) concentrations in the first week post-calving were lower in the CRC and RPC+CRC groups than controls (990, 1140 and 1553 $\mu\text{mol/L}$ respectively, $P<0.05$). NEFA concentrations in the first week post-calving were lower in the CRC group compared to control (0.51 and 0.70 mEq/L, respectively, $P<0.01$). In both the first week pre-calving and the first week post-calving, the concentrations of serum urea were higher in the CRC group (4.03 & 4.54mmol/L, respectively) and RPC+CRC group (4.12 & 4.51 mmol/L, respectively) in comparison to the CON group (3.67 & 4.02 mmol/L, respectively) ($P<0.05$). During the first week post-calving higher serum glucose concentrations were observed in both the CRC and RPC+CRC groups in comparison to the CON group (2.76, 2.72 and 2.43mmol/L, respectively, $P<0.05$). There was no treatment effect on DMI pre or post-calving. There was no interaction between CRC and RPC on milk production, and no significant main effects of CRC on milk production. Data were pooled into two groups, cows receiving RPC and cows not receiving RPC. Adjusting for treatment, parity, BCS at enrollment, week of lactation and average post-calving DMI there was a tendency ($P=0.06$) for the RPC group to produce more milk in the first 60 DIM compared to cows that did not receive RPC (32.6 vs 31.7 kg/d respectively). According to the results from this study thus far, the mechanism by which RPC enhances milk production remains unclear.

Key Words: Dairy, Choline, Monensin

516 Effect of the method of delivery of monensin on serum insulin and cortisol concentrations in transition dairy cows. C. S. Petersson^{*1}, K. E. Leslie², T. F. Duffield², T. M. Osborne², B. W. McBride³, R. Bagg⁴, and P. Dick⁴. ¹Department of Animal Sciences, Ohio State University, Columbus, ²Department of Population Medicine, University of Guelph, Guelph, ON, Canada, ³Department of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada, ⁴Elanco Animal Health, a Division of Eli Lilly, Inc., Research Park Centre, Guelph, ON, Canada.

An investigation was conducted to compare the effects of the monensin controlled-release capsule (CRC), the monensin premix and a negative control group on serum insulin and cortisol concentrations in a randomized and blinded clinical trial. A total of 136 Holstein cows and heifers from the Elora Dairy Research Centre were enrolled at three weeks prior to expected calving date. At enrolment, each animal was randomly assigned to receive a monensin CRC, monensin premix in the TMR or no treatment. Blood samples were obtained at enrolment, at one week prior to expected calving date, at calving, and at one and two weeks postpartum. The serum from these samples was analyzed for insulin and cortisol concentrations. Monensin had no effect on serum insulin concentration over the study period. However, serum insulin concentrations were higher prior to calving as compared to the postpartum period. Additionally, the serum concentration of insulin in heifers was significantly increased compared to multiparous animals. A seasonal effect found that the serum concentration of insulin was lowest in the summer as compared to the spring, winter and fall seasons. Monensin administration had no effect on serum cortisol concentration throughout the study period. However, statistical variation over time was observed; the highest concentrations occurred at calving.

Key Words: *Escherichia coli*, Mastitis, Vaccination

517 Determination of the test characteristics of a rapid, on-site serum NEFA test. L. Gooijer, K. Leslie*, T. Duffield, S. LeBlanc, N. Perkins, and E. Vernooy, University of Guelph, Guelph, ON, Canada.

Excessive or prolonged periparturient negative energy balance (NEB) may be associated with increased risk of clinical disease and losses from impaired production and reproductive performance. Monitoring the incidence of subclinical ketosis has been the recommended method of surveillance. It has been found that affected cows commonly have elevated circulating levels of non-esterified fatty acids (NEFA) in the prepartum period. However, measuring NEFA has traditionally involved submission of serum to a diagnostic laboratory. The objective of this

study was to determine the test characteristics of a new, rapid, on-site test for NEFA in serum (DVM NEFA, Veterinary Diagnostics LLC, Newburg, Wisconsin, USA). Cows were enrolled between 7 and 4 days prior to their expected calving date. Blood was collected by coccygeal venapuncture and serum was harvested. Cows were re-sampled twice weekly until calving. NEFA concentration was measured using the DVM NEFA test, and an aliquot was submitted to the Animal Health Laboratory (AHL) of the University of Guelph for analysis by a Hitachi 911 automated analyzer (Roche, Laval, Quebec). The AHL NEFA concentration was considered the gold standard for this evaluation. Serum NEFA greater than or equal to 0.4 mEq/L NEFA has been proposed to identify excessive prepartum NEB. A total of 491 samples from 256 different cows on eight farms in the Guelph, Ontario area were utilized in this study. The Pearson correlation coefficient between the DVM NEFA and the AHL NEFA determination was 0.75. Using 350 samples drawn within 14 d prepartum and NEFA greater than or equal to 0.4 mEq/L from the AHL test as the gold standard, the sensitivity and specificity of the DVM NEFA test were 84% and 96%, respectively. It is noteworthy that changing the NEFA cut off level to greater than or equal to 0.5 mEq/L resulted in a similar sensitivity and specificity of 85% and 97%, respectively. It was concluded that the DVM NEFA test characteristics were satisfactory for detection of cows with elevated prepartum NEFA.

Key Words: Non-Esterified Fatty Acid, Negative Energy Balance, Test

518 DCAD affects responsiveness of cows to parathyroid hormone -how anion supplementation prevents milk fever. J. P. Goff* and R. L. Horst, USDA-ARS, National Animal Disease Center, Ames, IA.

How adjusting dietary cation-anion difference (DCAD) reduces milk fever incidence remains debatable. Our hypothesis is that DCAD affects acid-base status of the cow altering the action of parathyroid hormone (PTH) on its target tissues, primarily bone and kidney. PTH normally stimulates renal synthesis of 1,25-dihydroxyvitamin D (1,25- vit D) and the effects of 1,25-vit D on intestine, and PTH on bone, cause a rapid rise in plasma Ca concentration. To test this hypothesis, Jersey cows in late gestation were fed a Low DCAD (N=8) or a High DCAD diet (N=8) for 2 wks. Urine pH averaged 5.7 in Low DCAD and 8.3 in High DCAD cows indicating the diets did affect acid-base status. Baseline blood samples were collected from each cow. Then 0.5 mg PTH 1-34 was administered IM, with additional injections of 3.3 mg PTH given every 3 h for 48 h. Blood samples were obtained every 3 h during PTH treatment and plasma Ca and 1,25-vit D concentrations were determined. Repeated measures ANOVA demonstrated significant time by diet effects on both plasma Ca and 1,25- vit D. Cows fed Low DCAD had a significant increase in plasma Ca from baseline at 6 h of PTH treatment and plasma Ca continued to increase with PTH treatment. In High DCAD cows plasma Ca did not increase from baseline until 21 h and continued to increase with PTH treatment. Plasma 1,25- vit D was above baseline in Low DCAD cows at 6 h of PTH treatment, peaked at 24 h of PTH treatment and remained elevated. In high DCAD cows there was a small but significant spike in plasma 1,25-vit D concentration at 6 h of PTH treatment but values at 9 and 12 h of PTH treatment were not significantly elevated from baseline. Plasma 1,25- vitD concentration rose above baseline at 15, 24, 30 and 33 h of PTH treatment but were similar to baseline at 18, 21 and 27 h of PTH treatment. These data demonstrate that High DCAD causes a pseudohypoparathyroid state in which tissues are less responsive to PTH stimulation, which impairs Ca homeostasis to cause milk fever. Low DCAD diets restore tissue PTH sensitivity, preventing milk fever.

Key Words: DCAD, Milk Fever, Parathyroid Hormone

519 Impact of participation in somatic cell count testing on herd average somatic cell score. H. D. Norman, A. H. Sanders*, R. H. Miller, and R. L. Powell, Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.

Mastitis results in substantial loss for dairy producers through lost milk and cow treatment or replacement. Test day data for somatic cell score (SCS) is stored in the national database at the Animal Improvement Programs Laboratory (AIPL). Since 1995, national herd average SCS has increased slightly. Also in that time, emphasis on SCS in the Net Merit index was increased from 6 to 9%, recognizing the value of improving udder health. To examine the impact of participation in official

somatic cell count (SCC) testing, herd mean SCS for 692,993 test days in 15,869 herds that began SCC testing between July 1995 and February 2004, having at least 6 mo on SCC testing, were analyzed for within herd effects of months on test. Herds were assumed to have stopped testing if no test was reported for >6 mo. Significant seasonal effects were accounted for by including month of test in the model; SCS was highest in August and lowest in November. Herd effect was nested in time of first test (month and year). Overall, mean first SCS test was 2.99; however, herds beginning SCC testing more recently had lower first SCS test (regression of first SCS on time of first test of -0.03). From the first to the second month on testing, SCS decreased by 0.14 ($P = 0.05$), but returned to starting level by 6 mo, and continued to increase over the subsequent 42 mo. Conversely, milk production increased significantly from the first to the second month of SCC testing, but decreased as SCC increased. These results were more pronounced in herds not previously on official milk testing. Increasing herd size was associated with a reduction in SCS, but including number of cows on test day produced similar results for effects of time on test. Frequency of testing did not significantly affect results. The national average of herd SCC and percentage of herd SCC exceeding 750,000 cells/ml have been increasing, the results of this study indicate that somatic cell testing can provide information valuable in reducing herd SCC, but producers may not fully utilize this information.

Key Words: Somatic Cell Score, Mastitis, DHIA

520 Dairy herd characteristics, management practices and mastitis prevalence data from farm visits to improve milk quality in New York and surrounding states. D. Wilson*, R. Gonzalez, G. Bennett, H. Schulte, J. Spatz, L. Tikofsky, F. Welcome, and Y. Schukken, *Quality Milk Production Services, Cornell University, Ithaca, NY.*

From January through November, 2003 the Quality Milk Production Services made 1294 herd visits and collected 76,346 aseptic milk culture samples from those visits in New York, Pennsylvania, Massachusetts, and Vermont. These visits were made either to monitor and maintain milk quality, or because of concerns about elevated bulk tank SCC. Mean SCC for herds monitoring milk quality was 384,000/ml. Herd size averaged 92 lactating plus dry cows, range 5-1648 cows. The smallest 400 herds had fewer cows than the largest 10 herds. Milk production 305-d mean was 14,903 lb with 90th percentile 22,000 lb. 1.5% of herds sold 50,000-710,000 lb/day, 2.5% sold <300 lb/day. Holstein breed was most common, with Holstein crosses also more common than any other breed. Tiestalls were most common housing type but freestalls were increasing. Dry cows were housed with lactating cows (45%) or a variety of other housing types. Milking systems included pipeline (67%), parlor (21%), and bucket (as only milking system, 12%). Parlor usage was increasing. Predip (63%), udder wash (24%), postdip (85%), dry cow therapy (all cows 84%, selected 7%) were practices increasing in adoption. Closed herds (53%) are decreasing. Trends toward fewer larger herds, freestalls, adoption of milk quality practices, and associated improved milk quality are evident. Some effective mastitis control methods still are not adopted by a substantial fraction of dairy farms, including large operations.

Key Words: Mastitis, Milk Quality

521 Efficacy of intramuscular ceftiofur combined with intramammary pirlimycin or cephalixin for treatment of systemically mild clinical mastitis in dairy cattle. J. R. Wenz*, R. Elia, D. Pruna, F. B. Garry, and R. P. Dinsmore, *Integrated Livestock Management, Colorado State University, Fort Collins.*

The objective of this study was to evaluate the impact of IM ceftiofur on important outcomes of systemically mild clinical mastitis. Cows from a 1500 cow dairy with clinical mastitis were randomly assigned to a treatment group: M1-intramammary (IMM) pirlimycin (n=35), M2-IMM pirlimycin and ceftiofur (n=36), M3-IMM cephalixin (n=40), M4-IMM cephalixin and ceftiofur (n=33). Pirlimycin was administered as labeled. Cephalixin was administered twice a day for three days. Ceftiofur was administered IM (2mg/kg) once a day for 3 days. Milk was cultured at initial identification (0hr), on exit from sick pen and 7 days post-exit. Cows with abnormal milk 3 days after the end of initial IMM treatment were re-treated. Recurrent clinical mastitis was diagnosed in cows with a subsequent clinical mastitis episode in the same quarter within 3 months. Bacteriologic cure was defined as no growth or growth

different from 0 hr culture results on both exit and 7 day post-exit cultures in cows that did not require re-treatment. Effects of treatment (IMM and IM) on outcomes were analyzed by logistic regression accounting for Gram staining characteristics (GRAM) of 0 hr bacterial culture result (SAS, PROC LOGISTIC). Sixty-nine, 22 and 9 % of 0hr cultures were Gram negative, Gram positive and mixed, respectively. There was a significant difference in bacteriologic cure of ceftiofur treated cows (75%) compared to IMM only treated cows (50%) controlling for IMM treatment and GRAM ($P=0.048$). However, there was no difference in re-treatment or recurrence rate comparing treatment group or ceftiofur treatment alone ($P>0.40$). Treatment had no effect on the number of dried quarters, cows sold for or dying from mastitis or sick pen days. The results of this limited study in one herd, with a predominance of Gram negative clinical mastitis, suggest IM ceftiofur treatment has no beneficial effects on the outcome of systemically mild clinical mastitis.

Key Words: Mastitis, Treatment, Ceftiofur

522 The effects of two *Escherichia coli* J5 immunization protocols on milk production, dry matter feed intake, antibody response and intramammary infection in dairy cattle. C. S. Petersson*¹, K. E. Leslie², D. F. Kelton², B. A. Mallard³, and S. W. Martin², ¹Department of Animal Sciences, Ohio State University, Columbus, ²Department of Population Medicine, University of Guelph, Guelph, ON, Canada, ³Department of Pathobiology, University of Guelph, Guelph, ON, Canada.

An investigation was conducted to compare the effects of two *Escherichia coli* J5 immunization protocols (Standard and Experimental) in 198 animals from two herds. Each immunization included the *E. coli* J5 bacterin and a naïve marker antigen, ovalbumin (OVA). The Standard Group was immunized at drying-off, three weeks before expected calving and 3-9 days postpartum. The Experimental Group was immunized at two weeks before drying-off, at drying-off and at three weeks before expected calving. Immunization protocol did not effect milk production for 14 days prior to drying-off, or to 60 days in milk. To evaluate the physiologic effects of immunization, dry matter feed intake values were collected for the 24 hours before the third immunization in the Standard Group, as well as the 24, 48 and 72 hours after. The intake values were also collected for the same dates in the non-immunized Experimental Group. Dry matter feed intake was not affected by immunization in the postpartum period. Serum antibody to *E. coli* J5 did not increase following immunization in either group. Animals showed significant response to OVA, however, total peripartum antibody to OVA did not differ between the two groups. The risk of culturing a gram-negative pathogen at calving and the risk of gram-negative clinical mastitis was not different between the two protocols.

Key Words: Insulin, Cortisol, Parturition

523 Tunnel ventilation cooling for lactating dairy cows during hot weather: Comparison to cooling with shade and fans. T. R. Smith*¹, A. M. Chapa¹, D. O. Pouge², T. O. Riley², R. J. Williams¹, J. Crouch¹, and H. Wilson¹, ¹The Department of Animal & Dairy Science, Mississippi State University, Mississippi State, ²The Dairy Research Unit, Mississippi Branch Experiment Station, Holly Springs, MS.

The objective of this study was to characterize the ability of tunnel ventilation cooling to alleviate symptoms of heat stress in lactating dairy cows. Fans and evaporative "cooling" cells were used to cool the model, 20-cow tunnel ventilation facility, constructed at the Dairy Research Unit in Holly Springs, MS. The 10-week trial, which began June 2, 2003, compared two groups of 10 cows housed in the tunnel ventilation barn with two similar groups, housed in an adjacent "traditional" freestall barn, which was cooled by shade and fans alone. The effect of tunnel ventilation cooling was to decrease exposure to moderate heat stress conditions by 4.3 ± 0.26 hours/d when compared to conditions in the traditional freestall barns. In response, cows housed in the tunnel barn had dramatically lower peak body temperatures (0.67 ± 0.02 °C) and respiration rates (15.7 ± 0.54 breaths/min) than cows housed in the "outside" freestall barn ($P<.001$). This increment in cooling improved feed consumption within the tunnel barn an average of 1.8 ± 0.81 kg/hd/d over the 10-week study. In addition, over the 10-week trial, cows cooled by tunnel ventilation averaged 2.8 ± 0.7 kg/hd/d greater milk production ($P<.0001$) than cows cooled with shade and fans alone. These results demonstrate that tunnel ventilation cooling can be used

to mitigate the effects of heat stress on lactating dairy cattle in the southeastern US.

Key Words: Tunnel Ventilation, Dairy, Heat Stress

Breeding and Genetics: Dairy Crossbreeding and Breeding Objectives

524 Comparison of first-parity Holstein, Normande-Holstein crossbred, Montbeliarde-Holstein crossbred and Scandinavian-Holstein crossbred cows for dystocia and stillbirths. B. J. Heins*, L. B. Hansen, and A. J. Seykora, *University of Minnesota, St. Paul.*

First-parity Holstein (H), Normande-Holstein (NxH) crossbred, Montbeliarde-Holstein (MxH) crossbred and Scandinavian-Holstein (SxH) crossbred cows calving from June 2001 to December 2003 were compared for dystocia and stillbirths from seven California herds. Dystocia scores ranging from 1 (no assistance) to 5 (hard pull) and stillbirths (1 for alive and 0 for dead) were recorded for 1695 Holstein cows, 205 Normande-Holstein cows, 157 Montbeliarde-Holstein cows and 110 Scandinavian-Holstein cows. Cows were bred to Brown Swiss, Holstein, Jersey, Normande, Montbeliarde and Scandinavian sires. Investigated were effects of calf sex, breed composition of cow, age at calving, breed of service sire, calving year and herd. For dystocia, sex of calf, calving year, breed of dam, breed of service sire and herd were significantly different ($P < .05$). The least squares mean for calf sex were 1.55 for males and 1.19 for females. Mean scores for dystocia for breed of dam were 1.59 (H), 1.44 (NxH), 1.26 (MxH) and 1.19 (SxH). Holstein sired calves (1.52) differed significantly ($P < .05$) from Jersey sires (1.11), and Holstein sires differed ($P < .01$) from Scandinavian sires (1.30). For stillbirths, sex of calf, calving year, breed of dam, breed of service sire and herd were significantly different ($P < .01$). Male calves (12%) had higher stillbirths than females (2%). Mean scores for stillbirths for breed of dam were 12% (H), 8% (NxH), 3% (MxH) and 5% (SxH). Holstein sires had the highest rate of stillbirths (12%), and rates for the other breeds of sires were 10% for Brown Swiss, 3% for Jersey, 7% for Montbeliarde, 4% for Normande, and 5% for Scandinavian sires. Holstein sires differed significantly from Jersey ($P < .05$) and Scandinavian sires ($P < .01$). Brown Swiss differed significantly from Scandinavian sires ($P < .05$).

Key Words: Crossbreeding, Dystocia, Stillbirths

525 Comparison of the fertility of pure Holstein sires and F1 Jersey x Holstein sires mated to pure Holstein cows in an experimental herd. K. Weigel* and C. Maltecca, *Department of Dairy Science, University of Wisconsin, Madison.*

The objective of this study was to compare the male fertility of pure Holstein service sires and crossbred F1 Jersey x Holstein service sires in artificial insemination (AI) matings to pure Holstein cows. Approximately 60% of matings involving Holstein cows in the University of Wisconsin Experimental Herd were randomly allocated to F1 Jersey x Holstein young sires ($N=7$) from Alta Genetics, Select Sires, ABS Global, and Accelerated Genetics. The remaining matings were allocated to pure Holstein young sires ($N=52$) from seven commercial AI companies. Our analysis included 429 inseminations (166 cows) to crossbred sires and 288 inseminations (124 cows) to Holstein sires between February 3, 2003 and January 28, 2004. Pregnancy status was determined by ultrasound at 28 to 33 d after breeding. All pregnant cows were re-checked twice, at approximately 63 d and 100 d after breeding. Mean conception rates were 29.2% (84/288) for matings to pure Holstein sires and 30.3% (130/429) for matings to F1 Jersey x Holstein sires. Conception rates for individual crossbred sires were 27.4%, 27.6%, 30.7%, 29.1%, 34.7%, 35.4%, and 0.0% based on 73, 69, 75, 55, 45, 99, and 9 matings, respectively. Abortion rates (after a positive ultrasound at 28-33 d) were 7.1% (6/84) for pregnancies from Holstein sires and 14.6% (19/130) for pregnancies from crossbred sires. Based on Chi-Squared test statistics, corrected for days in milk and year-month of insemination, neither differences in conception rates nor differences in abortion rates between purebred and crossbred sires were statistically significant ($P < 0.05$). Based on the results of this study, it does not appear that crossbred Jersey x Holstein sires can provide a significant improvement in male fertility relative to their pure Holstein contemporaries.

Key Words: Male Fertility, Crossbreeding

526 A comparison of reproductive efficiency in four breeds of dairy cow and two cross breeds under seasonal grass-based production systems in Ireland. F. Buckley*, J. F. Mee, N. Byrne, M. Herlihy, and P. Dillon, *Teagasc, Dairy Production Research Centre, Moorepark, Fermoy, Co. Cork, Ireland.*

The objective of this study was to compare the reproductive performance of four dairy cow breeds, and two cross breeds; Holstein-Friesian (HF), French Montbeliarde (MB), MBxHF, French Normande (NM), NMxHF, and Norwegian Red (NRF), over a three year period, on two seasonal grass-based milk production systems. The study included a total of 402 cows: 95 HF, 72 MB, 63 MBxHF, 36 NM, 58 NMxHF, and 78 NRF. The mean calving date was February 18. In mid-April each year cows were assigned (within breed) to a low level of concentrate supplementation (LC: 650kg/cow/lactation) or a high level of concentrate supplementation (HC: 1,250kg/cow/lactation) based on calving date and pre-experimental milk yield. Breeding started in late April and lasted 13 weeks (all AI). No difference in the interval to commencement of luteal activity (as determined by thrice weekly milk progesterone measurement), submission rate in the first 24 days of breeding, or number of services per cow were observed between the groups investigated. Significant differences in pregnancy rate to first service (PREG1), pregnancy rate after 42 days of breeding (PR42) and calving to conception interval (CCI) were observed. Overall, the highest reproductive efficiency was observed with the NRF breed (PREG1 = 59%, PR42 = 75% and CCI = 88 days). The lowest reproductive performance was observed with the HF breed (PREG1 = 42%, PR42 = 56% and CCI = 96 days). The reproductive performance of both the MBxHF and the NMxHF was higher than the average of the respective parent breed groups. Feeding system had no influence on any of the fertility traits investigated. In conclusion, the results of the current study highlight the benefit of the NRF breeding program where improved health and fertility have been selection criteria since the early 1970's. The results also suggest that dairy crossbreeding will lead to improved reproductive performance through hybrid vigour.

Key Words: Dairy Breeds, Fertility, Hybrid Vigour

527 Effect of Holstein females carrying Holstein versus Jersey sired calves on subsequent MEMilk, days open and involuntary culling. A. J. Seykora*, B. J. Heins, L. B. Hansen, J. G. Linn, D. G. Johnson, and W. P. Hansen, *University of Minnesota, St. Paul.*

From September 2001 to June 2003, 163 Holstein and 180 Jersey-Holstein crossbred calves were born at the University of Minnesota research herds at the St. Paul campus and at the West Central Research and Outreach Center, Morris. Cows and heifers had been randomly assigned to either Holstein or Jersey service sires. Dystocia was scored with a range of 1 (no assistance) to 5 (hard pull). Independent variables for analysis were herd, parity (1st, 2nd and 3rd and greater), sex of calf, and breed of sire. Differences between Holstein and Jersey sires were significant for dystocia score, calf weight, and retained placenta ($P < .05$). Least squares means for Holstein and Jersey sires, respectively, were dystocia score, 1.97 versus 1.36; calf weight, 43.6 kg versus 35.7 kg; and retained placenta, 8.2% versus 3.6%. Stillbirth rate was 7.2% for Holstein sires and 5.2% for Jersey sires, but not significantly different ($P > .05$). There were no significant differences in the subsequent MEMilk, days open or chance of early culling (culled less than 100 days into lactation) for cows having Holstein versus Jersey sired calves. For all cows, cows that had been bred to Holsteins averaged 10,430 \pm 158 kg MEMilk versus 10156 \pm 155 kg for cows bred to Jerseys. Days open also favored the cows that had had Holstein sired calves: 138 \pm 8 days versus 143 \pm 8 days. Relative to early culling, 16.6 \pm 3.9% of cows having Holstein calves were culled vs. 14.1 \pm 3.7% of cows having Jersey sired calves. The analysis was repeated for just the first lactation cows.

Again breed of calf did not significantly affect MEMilk, days open, or chance of early culling.

Key Words: Crossbreeding, Dystocia, Fertility

528 Overview of different breeding objectives in various countries for Holsteins. F. Miglior*, *Agriculture and Agri-Food Canada - Canadian Dairy Network, Guelph, ON, Canada.*

For many years, most Holstein breeding schemes worldwide focused exclusively towards increasing milk production. In the last five years selection goals have evolved worldwide, shifting the focus on production to a more balanced selection goal of improving production, especially protein yield and percentage, as well as longevity, udder health, functional conformation and fertility. Selection indexes and top bull listings from 15 countries were compared. Average relative emphasis for Production, Durability and Health & Fertility, across all countries, was 59.5%, 27.9% and 12.6%, respectively. The largest difference was the relative emphasis on Production in various countries. Overall, the Danish S-Index appeared to be the most balanced across the three components, with 34% emphasis on Production, 29% on Durability and 37% on Health and Fertility. The broadening of selection goals through recent changes to selection indexes had a clear effect on decreasing the similarities of top bull listings in various countries.

Key Words: Dairy Cattle, Breeding Objective, Selection Index

529 Effect of inbreeding on female reproduction in Jerseys. J. P. Cassady*, J. C. Wilk, B. T. McDaniel, and S. P. Washburn, *North Carolina State University, Raleigh.*

The objective was to determine effects of inbreeding in Jerseys on age at first calving, days to first observed estrus, days to first insemination, conception rate, services to conception, days open, and survival to second lactation. Inbreeding has been increasing rapidly in U.S. Jerseys as documented by the Animal Improvement Programs Laboratory (<http://www.aipl.arsusda.gov/eval.htm>). Inbreeding in Jerseys has more than doubled from 3.4% in 1990 to 7.1% in 2003. Experimental data included first lactation records between 1970 and 1993 of 900 Jersey females raised in the North Carolina State Randleigh herd. These animals were from two selection experiments. One experimental line used only highly proven sires and the second experimental line used pedigree selected young sires. As a result, cows studied were daughters of popular Jersey sires. Thus, results are expected to be relevant to commercial Jersey herds. For statistical analyses, calculated inbreeding values for each animal were rounded to the nearest whole percentage. Data were adjusted for effects of selection line, birth year of the dam, calving month, calving year, MEMilk, and MEFat. Inbreeding did not significantly affect age at first calving, days to first observed estrus, days to first insemination, or survival to second lactation. However, increased inbreeding had significant, deleterious effects on first service conception rate, services to conception, and days open. A 1% increase in inbreeding reduced 1st service conception rate by 2 percentage points, increased services to conception by 0.05 services, and increased days open by 1.8 days. Jersey breeders should implement a selection program that increases productivity and minimizes inbreeding. Effective mating programs to guide Jersey breeders in accomplishing these goals are recommended.

Key Words: Dairy, Inbreeding, Reproduction

530 Effect of synchronization protocols on days open and pregnancy rate at 120 days in dairy cattle. R. C. Goodling*¹, G. E. Shook¹, K. A. Weigel¹, N. R. Zwald¹, and R. D. Welper², *¹University of Wisconsin, Madison, ²Alta Genetics, Inc., Balzac, AB, Canada.*

Data were from herds in an AI progeny testing program that were utilizing Dairy Comp 305 and had at least 75% of recorded breeding events classified as standing heat or synchronized. A total of 16,374 records from 64 herds were analyzed. Data subsets were based on individual cow synchronization categories and herd management categories. Statistical models for days open (DO) included herd-year-season, age at calving, and parity as fixed effects, and sire or animal and residual as random effects. The pregnancy rate at 120 days (PR120) data were analyzed with a threshold sire model with similar fixed and random effects to DO. Models including a fixed effect for synchronization and a

random interaction for sire by herd management also were investigated. Producers who used synchronization, 47 herds in these data, were applying it selectively to problem cows. Records synchronized after the first breeding (later-synchronized) had 71 d longer DO and 24% lower PR120 than records synchronized at first breeding (first-synchronized). First synchronized records had 23 d longer DO and 10% lower PR120 than non-synchronized records. The 11 herds adhering strictly to synchronized first inseminations had 17 fewer DO and 10% higher PR120 than other herd management groups. Heritabilities ranged from 0.03 to 0.07 for DO and 0.10 to 0.26 for PR120. Sire variance was 40% lower for DO and 25% lower for PR120 in first synchronized records than either later-synchronized or non-synchronized records. Residual variances for DO varied by 3% between cow treatment categories and 14% for herd management categories. Including a fixed effect for synchronization in the DO model reduced sire variance by 33% and residual variance by 10%. Sire by herd management interaction accounted for less than 1% of the total variance for DO and 2% of the total variance for PR120. Synchronization had important, but similar, effects on sire and residual variances with only modest effect on heritability.

Key Words: Days Open, Estrus Synchronization, Heritability

531 Level of metabolic trait of glucose by young bulls and cows. L. Panicke*¹, E. Fischer², B. Fischer³, H. Behn⁴, and R. Staufenbiel⁴, *¹Research Institute for the Biology of Farm Animals, Dummerstorf, Germany, ²Agric. and Environmental Faculty of the University Rostock, Rostock, Germany, ³Institute of Agriculture and Horticulture of Sachsen-Anhalt, Iden, Germany, ⁴Free University Berlin, Clinic of Cattle and Pigs, Berlin, Germany.*

The breeders are interested in premature information about the evaluation of growing young bulls. The common contemplation of genetic and physiological aspects is offered. In the lactation, the milk performance influences the demand for glucose. Insulin has a central position in the regulation of the energy metabolism of cattle. Methodically, the insulin function can be measured using the glucose tolerance test (GTT, Reinicke,1993). 58 cows in the stage of partus to 15 weeks post parturition was compared with 392 young bulls in the third life half-year. The goal of the examination was, to establish a comparable test level for cows and growing young cattle. By an infusion of 1g glucose per kg^{0.75} of metabolic body weight in the GTT was kept the urine threshold of Burkert (1998) and Reinicke (1993). By the constant glucose base concentration (G₀), the glucose half-life (G_{HWZ}) of the young bulls at 48 min is comparable with the eighth week of the lactation of the cow (see Tab.). Exactly in this time period has been proved by Cassel (2001) the highest genetic correlation between energy balance and yield r_g = -0.84 and the highest heritability for the energy balance h² = 0.20. Thus, by the infusion quantity and the expelled test time under performance the young bulls imitate the genetic equipment of their daughters for the metabolism capability.

Results of the Glucose Tolerance Test (GTT) in young bulls according to test in the third life half year and cows by partus and later 4, 8 and 15 weeks

		Wt.	Wt.	G ₀	G ₀	G _M	G _M	G _{HWZ}	G _{HWZ}
		kg	kg	mmol/ l*	mmol/ l*	mmol/ l**	mmol/ l**	min #	min #
year	n	x	s	x	s	x	s	x	s
Bulls									
1999	96	460	48	4.4	0.6	13.4	1.4	49.9	14.4
Bulls									
2000	105	447	46	4.4	0.7	13.7	1.8	47.6	15.7
Bulls									
2001	91	443	37	4.6	0.5	14.1	1.5	45.7	10.5
Cows by									
partus	28	551.6	38.7	4.0	0.4	11.1	1.4	43.1	8.5
4									
w.p.p.	10	542.5	38.7	3.4	0.4	11.2	1.6	37.7	5.6
8									
w.p.p.	10	566.0	23.2	4.0	0.5	11.7	1.9	48.9	18.0
15									
w.p.p.	10	542.0	31.9	3.9	0.3	12.0	1.8	55.5	24.4

*G₀ = glucose basis; **G_M = maximal value;
#G_{HWZ} = glucose half life time; x=mean value; s=standard deviation

Key Words: Cattle, Breeding Value, Glucose

532 Heterosis and breed differences for daughter pregnancy rate of crossbred dairy cows. P. M. VanRaden, M. E. Tooker*, and J. B. Cole, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Fertility of crossbred and purebred dairy cows was compared based on daughter pregnancy rate (DPR) as defined and introduced in February 2003 by the USDA. Heterosis and breed differences were estimated from first parity records of 11,708 F1 crossbred cows and 195,123 purebred contemporaries born after 1987 in 5775 herds. A second analysis for parities 1 through 5 included 485,297 records. Lactations were required to be >250 days in milk. Records with >250 days open were set to 250 days open and records with <50 days open were set to 50 days open. Numbers of purebred contemporaries were 1,679 Ayrshires (AY), 1,259 Brown Swiss (BS), 1,926 Guernseys (GU), 191,872 Holsteins (HO), 8,812 Jerseys (JE), and 396 Milking Shorthorns (MS). The most numerous F1 cross was 5,563 progeny of JE sires mated to HO dams. Days open records were converted to DPR by the linear approximation $DPR = .25$ (233 days open). To compare base cows born in 2000, sire predicted transmitting abilities for DPR were adjusted to the 2000 genetic base and subtracted from DPR records. The model for adjusted DPR included age at first calving, herd-year-season of calving with three seasons per year, parity, heterosis, and breed effects as compared to purebred HO. Estimates of heterosis for DPR were $+2.4 \pm 0.6$ for first parity and $+1.8 \pm 0.5$ for all parities. Within herd-year-season estimates of breed differences and standard errors were AY $+0.9 \pm 0.9$, BS $+0.9 \pm 0.8$, GU $+2.2 \pm 1.2$, JE $+3.9 \pm 0.5$, MS $+4.5 \pm 1.8$ for first parities and AY $+1.8 \pm 0.5$, BS $+0.1 \pm 0.4$, GU $+2.0 \pm 0.7$, JE $+4.6 \pm 0.3$, MS $+4.3 \pm 1.0$ for all parities. Those estimates were similar to differences obtained from national breed averages for first parity DPR, which were AY 22.8, BS 21.9, GU 21.3, HO 22.3, JE 27.0, and MS 26.0 for cows born in 2000. JE x HO crossbreds are as fertile as purebred JE, and heterosis for DPR is about 10% of mean DPR. Crossbred cows have significant advantages over their purebred parents for daughter fertility.

Key Words: Crossbreeding, Heterosis, Fertility

533 Calving difficulty in Holsteins and Jerseys and their crossbreeds. S. McClintock*^{1,2}, B. Kevin^{3,2}, M. Wells², and G. Michael^{1,2}, ¹University of Melbourne, Melbourne, Australia, ²Primary Industries Research Victoria, ³Australian Dairy Herd Improvement Scheme.

Calving traits for frequently used dairy breeds and crossbreeds were investigated for primiparous and multiparous calvings, using 402,116 calving records collected in Australia for a period of 18 years. The incidence of dystocia was highest for Holstein-Friesian primiparous cows, and Jersey-Holstein crosses had the least dystocia. There was a strong interaction between calf sex and breed: male calves from Holstein-Friesian cows resulted in more dystocia and greater calf mortality than female calves, whereas male and female Jersey-sired calves with cross bred or Holstein dams had less difference in dystocia and calf mortality between the sexes. There was no significant difference between sexes in dystocia in Jersey calves. Logit transformation of proportion suffering dystocia reduced but failed to eliminate these significant interactions. Incidence of dystocia in Holsteins was influenced by the season (gestation lengths were longer in winter, resulting in larger calves and more dystocia) and by the age of the cow, but these fixed effects were not apparent in Jersey calvings, and less noticeable in Jersey cross calvings. Though there was a major breed difference for calving ease between Jersey and Holstein bulls, the bull standard deviations of the two breeds for this trait were sufficiently large, relative to the breed differences, that there will be a small percentage of Holstein bulls that may be as easy calving as many Jersey bulls.

Key Words: Dystocia, Crossbreed, Sex

534 Early results of Holstein-Jersey crossbreeding at Virginia Tech and Kentucky. B. G. Cassell*¹, K. E. Getzewich¹, R. L. Nebel¹, R. E. Pearson¹, S. T. Franklin², and A. J. McAllister², ¹Virginia Polytechnic Institute and State University, Blacksburg, ²University of Kentucky, Lexington.

The joint Virginia Tech - Kentucky crossbreeding project produced 88 calves at Virginia Tech and 18 at Kentucky by mid-February 2004. Limited data from Kentucky precluded its use here, but data from both

institutions will be combined in coming months. The project was initiated using a heterospermic insemination trial, whereby females were inseminated with a mixture of semen from one Holstein and one Jersey bull in a single straw. Dams were purebred Holsteins and Jerseys, ranging in age from heifers through fifth lactation cows when bred. Six sets of twins (excluded from analysis) were among the first 88 births, including three sets of mixed sex (females all freemartin), two sets of heifers, and one set of bulls. Five of the twins were stillborn or died by 24 hrs, and only two reproductively sound females survived. Dystocia scores (1-5) were recorded at birth. Calf mortality included stillbirths and calves dead by 48 hours. Calf weights were recorded periodically, but only birth weights are reported here. Breed combinations (HH, HJ, JH, and JJ, sire first) included 30, 21, 11, and 14 calves respectively. Over 80% of births were unassisted, dystocia score 1, with an average score of 1.42. Death losses were 6.7% for the 76 single births. A fixed model including effects of sex of calf, breed group, and lactation number of the dam evaluated dystocia, calf mortality, and birth weight. No significant differences existed for any effects for dystocia or calf mortality. Thus, we found no difference in dystocia for Holstein sired calves born to Jersey dams or Jersey sired calves born to Holstein dams. Birth weight differed significantly ($P < 0.05$) for sex (males heavier than females by 2.6 kg) and breed combination (HH calves heavier by 15.3 kg, HJ by 6.7 kg, and JH by 8.2 kg than JJ calves). Calves born to first calf heifers were 3.7 kg lighter than calves born to third and later lactation cows. The project is designed to produce 40 females per breed group at Virginia Tech and an additional 20 animals per breed group at Kentucky. To date, the Virginia Tech project has produced 16 HH, 8 HJ, 8 JH, and 8 JJ females after death and freemartin losses.

Key Words: Crossbreeding, Holstein-Jersey, Calfhood Survival

535 Normande-Holstein crossbreds versus pure Holsteins for conception, days open, calving interval and survival. B. J. Heins*, L. B. Hansen, and A. J. Seykora, *University of Minnesota, St. Paul.*

Normande-Holstein first parity crossbreds ($n=32$) were compared to pure Holsteins ($n=161$) for first service conception rate, services per conception, days open and survival to second lactation. Cows were housed in five commercial dairies in California and calved in a six-month period from June 2002 through November 2002. All cows in the study had A.I. sires and maternal grandsires. Cows having Days open greater than 270 days were truncated to 270 days. Independent variables were breed (Holstein, Normande-Holstein crossbred), age at calving (linear, months) and herd (5). Normande-Holstein crossbreds had a higher first service conception rate ($34\% \pm 8$) compared to Holsteins ($20\% \pm 4$). Holstein cows had more days open (135 ± 8) compared to Normande-Holstein crossbreds (109 ± 14). One-hundred percent of the Normande-Holstein crossbreds became pregnant and 97% of the Holsteins became pregnant. Of the cows that became pregnant, Normande-Holstein crossbreds had fewer services per conception compared to Holsteins. Least squares means were $2.52 \pm .32$ (Normande-Holstein) and $2.91 \pm .18$ (Holstein). For the cows that calved a second time, least squares means for calving interval were $383\text{-d} \pm 17$ (Normande-Holstein) and $419\text{-d} \pm 10$ (Holstein). Sixteen Holstein cows and one Normande-Holstein crossbred cow were culled during first lactation.

Key Words: Crossbreeding, Fertility, Days Open

536 Breed composition codes for crossbred dairy cattle in the United States. J. Cole*, M. Tooker, P. VanRaden, and J. Megonigal, Jr., *Animal Improvement Programs Laboratory, Agricultural research Service, USDA, Beltsville, MD.*

Crossbred animals in the US dairy cattle population do not currently receive genetic evaluations. A system for storing breed composition data was developed and the software implemented. Crossbreds are animals whose sire and dam breeds are known but different. Two ways that crossbred animals may be handled in an evaluation are: they may be included in the breed-of-sire evaluation, or all animals may be combined into a single evaluation. For each crossbred cow ($n=431,432$) the database stores animal identification, breed of animal registry, breed fractions for 18 dairy breeds and an unknown category, a four-generation breed stack, a sire breed stack, and a heterosis value. Standard two-letter breed codes are used in the breed stacks. Breed fractions were calculated from pedigree information in the USDA database as far back as data were available. As a result, the crossbred table includes >70,000 crosses that

occurred >4 generations back in pedigrees, resulting in one breed with a very large contribution (e.g. 96.9% HO) to the breed composition and the other with a very small contribution (e.g. 3.1% JE). To avoid confusion the data may be reformatted for presentation (e.g. 97HO3JE), which would involve a small loss of precision. When purebred sires are used, the sire breed stack completely describes the mating system and may be used to identify rotational breeding programs. If crossbred sires are used, a four-generation breed stack is needed to identify reciprocal crosses that cannot be denoted by the breed composition alone. Consider a purebred Holstein sire mated to a purebred Jersey cow. Breed composition of a daughter would be 50HO50JE with a sire breed stack of HOJE and heterosis of 1.0. If that daughter were backcrossed to a Jersey bull, the resulting calf would have a breed composition of 75JE25HO, a sire breed stack of JEHOJE, and heterosis of 0.50. This system is necessary to facilitate implementation of across-breed genetic evaluations.

Key Words: Crossbreeding, Genetic Evaluation, Dairy Cattle

537 Effect of strain of Holstein-Friesian cow and grass based feeding systems on milk production, body weight, body condition score and reproductive performance. P. Dillon^{*1}, B. Horan^{1,2}, F. Buckley¹, J. Mee¹, and M. Rath², ¹Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland, ²Faculty of Agriculture, University College Dublin, Dublin, Ireland.

The objective of this study was to assess the biological efficiency of three strains of Holstein-Friesian (HF) cows in three grass-based systems. For

this purpose, 39 High production (HP) North American Holsteins, 39 High durability (HD) North American Holsteins, and 39 New Zealand (NZ) Holsteins were used in three consecutive years. Each strain was allocated to one of three feed systems (FS); high milk output per cow (MP), high concentrate (HC), and high milk output per unit area (HS). Concentrate supplementation averaged 384, 384 and 1,455 kg per cow for MP, HS and HC, respectively. Milk yields were recorded on five days per week, milk composition was determined in one successive morning and evening sample each week. Body weight (BW) was recorded weekly and body condition scores (BCS) every three weeks. Cows were inseminated using AI, over a 13-week period. Milk production, BW, BCS and reproductive data were analysed as a split-plot design, using statistical procedures of SAS. There was a significant strain of HF by FS interaction for milk ($P < 0.01$), fat ($P < 0.01$), protein ($P < 0.01$) and lactose ($P < 0.001$) yields. Milk yield response to increased concentrate supplementation was greater with the HP strain. The NZ strain maintained the highest BCS and lowest BW. The HD strain had similar BW to the HP strain, while the BCS of the HD strain was higher than the HP strain ($P < 0.05$). Interaction between strain of HF and FS was not significant for the reproductive variables. The HP strain had greater number of services, lower conception rate to first service, and overall pregnancy rate, than both the NZ and HD. The NZ strain had higher conception rate to first and second service, and 6-week in-calf rate than both the HP and HD, while the HD was higher than the HP strain. FS had no effect on reproductive variables. The results indicate that the optimum system of milk production will vary with strain of HF.

Key Words: Dairy Cows, Grazing, Strain By Feed Interaction

Dairy Foods: Cheese

538 Use of reverse osmosis concentrated milk for the manufacture of Cheddar and Colby cheese: Impact on Ca equilibrium and functional properties. M.-R. Lee^{*}, J. A. Lucey, and M. E. Johnson, *University of Wisconsin, Madison.*

The physical characteristics of cheese are governed by proteolysis and electrostatic and hydrophobic interactions as influenced by pH and casein bound Ca (INSOL CA). The objective of this study was to study of the role of Ca equilibrium and pH on functionality changes that occur during ripening. Reverse osmosis (RO) of milk was performed before cheese making which increased the total solids content of cheesemilk by 2%. The additional lactose (0.5%) in RO milk, if fermented, could greatly decrease cheese pH and increase solubilization of Ca. Cheddar and washed curd Colby cheeses were made from RO and non-RO milk with different renneting and draining pH to vary total Ca content of cheeses. Changes in INSOL CA were determined by titration and cheese juice methods. Rheological properties were determined by small amplitude oscillatory rheometry during heating from 5 to 80°C and meltability from UW-Melt Profiler test where the degree of flow at 60°C was determined. The texture of RO Cheddar cheese with low renneting and draining pH was very crumbly (pH dropped to #88044.7). The INSOL CA in cheese decreased during aging in all cheeses. INSOL CA in cheese was positively correlated with cheese pH in both RO ($r = 0.89$) and non-RO ($r = 0.83$) trials. Above pH 4.95, changes in INSOL CA in cheese during ripening were negatively correlated with the maximum loss tangent value (i.e., point when cheese was most fluid-like) ($r = -0.54$) and with degree of flow ($r = -0.56$). Below pH 4.95, there was no significant relation between melting and INSOL CA. These results suggest that for cheese at pH < 4.95, melt was limited and loss of insoluble Ca in cheese during ripening could not improve melt due to dominant effects of low pH on the casein network. In cheeses with pH > 4.95, the reduction of INSOL CA in cheese during ripening contributed to increased meltability.

Key Words: Insoluble Ca, Meltability, Rheology

539 A comparison of three different methods for measuring intact casein in cheese. P. Lehtola^{*} and L. E. Metzger, *MN-SD Dairy Foods Research Center, University of Minnesota, St. Paul.*

Intact casein is a fundamental constituent in process cheese because it has important emulsifying properties that significantly affect the texture, stability and melt characteristics of the final product. In the traditional method for measuring intact casein 0.75g of cheese is extracted

twice with 25ml of a pH 4.6 buffer. The cheese is dispersed with a high shear mixer, extracted at room temperature for 30 min, and centrifuged. The supernatant obtained is then analyzed for soluble protein using the Kjeldahl method. Intact casein is determined by subtracting the amount of soluble protein from the total protein. The objective of this study was to develop two alternative procedures for measuring intact casein in cheese. In the first new method, 2.5 g of cheese is extracted once with 15 ml of pH 4.6 buffer. As in the traditional procedure, the cheese is dispersed using a high shear mixer, extracted for 30 minutes and centrifuged. Subsequently the supernatant and fat plug is removed and the amount of insoluble protein in the pellet is determined using the Dumas combustion method. In the second new method, .17 g of cheese is extracted once with 1 ml of pH 4.6 buffer. The extraction was performed in a micro centrifuge tube and the cheese was dispersed with a bead blaster. Following centrifugation the pellet was first washed with 1ml of a methanol/acetone solution (75:25) and then washed with 1 ml of acetone. The pellet was then dried in a heating block at 50°C for 1 hr. The final weight of the pellet was determined and used as a measure of insoluble protein. To compare the three methods eight samples of Cheddar cheese were analyzed at 2 wk, 2 months, and 4 months of ripening using each method. Each sample at each ripening time was analyzed in duplicate using each method. All methods observed a significant ($P < .05$) increase in soluble protein and a significant decrease ($P < .05$) in insoluble protein in all samples during ripening. The results of all three methods were highly correlated (>.90). This research has developed two alternative procedures for measuring intact casein in cheese.

540 Vatless manufacture of mozzarella cheese from 8X concentrated microfiltration retentate. A. V. Ardisson^{*} and S. S. H. Rizvi, *Department of Food Science, Cornell University, Ithaca, NY.*

The objective was to compare the functional and viscoelastic properties of low-moisture part-skim LMPS Mozzarella cheeses made by direct acidification with glucono- δ -lactone (GDL) and with starter culture. Both made by a continuous cheese-making process from concentration factor (CF) 8, pH 6.0 skim milk microfiltration retentate (MFR). Pasteurized skim milk was microfiltered to CF 8 at 50C using a 0.1 μ m nominal pore diameter microfiltration (MF) membrane unit with a total area of 9.2m². The system was equipped to maintain a uniform transmembrane pressure (UTMP) of 88.7 KPa. The milk was gradually acidified during MF to pH 6.0 using GDL (1.6g/kg skim milk) to adjust the calcium to casein ratio in the final retentate. The MFR was standardized with cream (40% fat) to produce a cheesemilk (CM) with

a casein to fat ratio of 1.1. GDL (1.7% w/w) or starter culture (1.3% w/w) was added followed by single strength rennet (80 μ /kg CM). CM was converted into cheese curd in an Alcurd continuous coagulator. The resulting curd was then cooked and stretched. The analyses performed on skim milk, retentate, CM and cheeses included total solids, protein (total N, non-protein N and non-casein N), fat and calcium. The cheeses made from MFR were compared to a control for compositional characteristics at day 1, and for functional (meltability and stretchability) and viscoelastic properties at 7, 30 and 60 days of age. All experiments were performed in triplicate.

The fat, moisture and protein contents of the cheeses produced from MFR showed no statistical difference ($p>0.05$) when compared to the control. Viscoelastic parameters (G and G) showed significant differences among the treatments at 7 days of age. However, at 30 days of age, the G and G values for the three treatments coincided at 14.1 kPa and 5.54 kPa, respectively. These trends were similar to those observed for meltability and stretchability, which were different ($p<0.05$) at day 7 but showed no difference at day 30. These results suggest that LMPS Mozzarella cheese can be continuously manufactured from microfiltration retentates and achieve compositional and textural characteristics similar to commercial LMPS.

Key Words: Microfiltration, Mozzarella

541 Influence of calcium, phosphorus, residual lactose, and salt-to-moisture ratio on cheese quality: manufacture and composition. P. Upreti*, R. Kapoor, S. K. G. Purna, and L. E. Metzger, *Department of Food Science and Nutrition, MN-SD Dairy Food Research Center.*

Four treatments of Cheddar cheese with two levels (high and low) of calcium (Ca) and phosphorus (P), and two levels (high and low) of residual lactose were manufactured. Each treatment was subsequently split in half and salted at two levels (high and low) for a total of 8 treatments. The 8 treatments included High Ca and P, High lactose, High S/M (HHH); High Ca and P, High lactose, Low S/M (HHL); High Ca and P, Low lactose, High S/M (HLH); High Ca and P, Low lactose, Low S/M (HLL); Low Ca and P, High lactose, High S/M (LHH); Low Ca and P, High lactose, Low S/M (LHL); Low Ca and P, Low lactose, High S/M (LLH); and Low Ca and P, Low lactose, Low S/M (LLL). All cheeses were made using stirred-curd procedure and were replicated three times. Treatments with a high level of Ca and P (HHH, HHL, HLH, HLL) were produced by cutting and drawing the whey at high pH (6.6 and 6.3 respectively), as compared to the treatments with a low level of Ca and P (LHH, LHL, LLH, LLL) (pH of 6.1 and 5.7 respectively). The lactose content in cheeses were varied by adding lactose (2.5% by weight of milk) to the cheese milk for high lactose cheeses (HHH, HHL, LHH, LHL), and washing the curd for low lactose cheeses (HLH, HLL, LLH, LLL). The difference in S/M was obtained by dividing the curds to be salted into two halves, weighing each half, and salting at 3.5 and 2.25% of the weight of the curd for high (HHH, HLH, LHH, LLH) and low S/M cheeses (HHL, HLL, LHL, LLL) respectively. All cheeses were salted at a pH of 5.4. The moisture and fat content of the cheeses ranged from 32.07 to 37.57%, and 33.32 to 35.93%, respectively. The total Ca and P in high Ca and P cheeses was on an average 0.67 and 0.47% Vs 0.53 and 0.39% for low Ca and P cheeses. The amount of residual lactose on the day after manufacture was significantly higher ($P<0.05$) for the high lactose treatments as compared to low lactose cheeses. The S/M for high and low salt cheeses was 6.68 and 4.77% respectively. The manufacturing conditions used in the study produced Cheddar cheeses with desired levels of Ca and P, residual lactose, and S/M.

542 Proteolysis and yield of Cheddar cheeses manufactured from milks with different serum protein contents. B. K. Nelson* and D. M. Barbano, *Northeast Dairy Foods Research Center.*

Our objective was to determine the impact of undenatured serum protein (SP) concentration in milk on proteolysis during Cheddar cheese aging. There were three treatments: control (0.52% SP), reduced SP (0.18%) and increased SP (0.69%). Skim milk was microfiltered (0.1- μ m pore size) to 3X in the first stage and then diafiltered twice to 3X using permeate from the UF of permeate from the MF as the diafilterant. The 3X MF retentate after the second diafiltration was diluted to the same casein content as the control milk with the UF permeate that was used as the diafilterant. The increased SP milk was produced by adding SP concentrate from the UF to skim milk. Cream was added to

all three milks to achieve a casein-to-fat ratio of about 0.7 and weights were determined for a mass balance of milk components. All manufacturing conditions were held constant for the three treatments and three replicates. The calcium content of the three treatment milks and cheeses were not different, indicating that using UF permeate as a diafilterant and diluent kept the calcium content at the same level as skim milk. There was no difference detected in initial cheese composition among the three treatments. Cheese make time was not affected by the milk SP content. The reduced SP treatment had a higher fat recovery in the cheese than the control or increased SP treatment and this resulted in a higher cheese yield efficiency for the reduced SP treatment. The rate of pH 4.6 soluble nitrogen (SN) production, expressed as a percentage of total nitrogen, was higher (indicating more primary proteolysis) in the cheese made from the reduced SP milk than control or increased SP, but 12% TCA SN was not affected by milk SP content. The ratio of α_s and β -CN to para- κ -CN was lower (17 h of pressing and at 30, 90, and 180 d of aging) in the cheese from low SP content milk. The lower ratio indicated that more CN had been proteolyzed. SP can be removed prior to cheese making without any detrimental impact on cheese composition or proteolysis.

Key Words: Cheddar, Microfiltration, Proteolysis

543 Gel microstructure, permeability and syneresis kinetics of cottage cheese-type gels made under different gelation rates. M. Castillo*^{1,2}, J. A. Lucey¹, W. Tao¹, and F. A. Payne², ¹*Department of Food Science, University of Wisconsin, Madison*, ²*Department of Biosystems and Agricultural Engineering, University of Kentucky, Lexington.*

Very little is known about syneresis in acid gels or in milk gels made by the combined action of acid and rennet (mixed gels), such as is sometimes used for cottage cheese manufacture. A factorial two-factor experiment with three replications was conducted to study the syneresis kinetics and the relationship between milk coagulation and syneresis at different coagulation rates. Effects of coagulation temperature and inoculum concentration on the microstructure and permeability of these mixed gels were also investigated. Coagulation parameters were concurrently monitored using rheology tests and near infrared light backscatter. Coagulation factors, such as inoculum level and temperature, had a direct effect on the development of the casein matrix, which impacted the physical characteristic of gels (e.g. particle rearrangement, permeability coefficient). These physical characteristics affected the extent and kinetics of the syneresis process. Whey drainage and curd shrinkage in mixed gels followed a first order kinetic reaction. The effect of temperature on kinetic rate constant for whey drainage allowed us to estimate both the thermal coefficient and the activation energy. A strong correlation was observed between syneresis parameters and those parameters characterizing acidification and network formation, which showed that coagulation kinetics played an important role in the syneresis process of mixed gels. Whey expulsion with time was predicted using a model that consisted of temperature and light backscatter parameters with an R^2 of 0.96. This suggests that it may be possible to develop a sensor capable of monitoring both coagulation and syneresis process, which could lead to greater control of the curd moisture content and an improvement of the final cheese homogeneity and quality.

Key Words: Syneresis Kinetics, Permeability, Cottage Cheese

544 Sensory differences among Pecorino Siciliano cheeses by geographic origin. J. Horne¹, S. Carpino*¹, S. Mallia¹, A. Difalco¹, G. Tumino¹, and G. Licitra^{1,2}, ¹*CoRFiLaC, Regione Siciliana, Ragusa, Italy*, ²*D.A.C.P.A. Catania University, Catania, Italy.*

Pecorino Siciliano is a PDO ewes' milk cheese produced in Sicily. The current study was undertaken to determine if location of production affects sensory properties of the cheese. Four months' ripened cheeses, respecting the traditional shape, were obtained from 15 farms from throughout Sicily that were classed into four groups by geography. Sensory characteristics were measured using a MS-based Electronic Nose (EN) and by a trained sensory panel. EN data were collected from a SPME extraction of volatile organic components from each cheese and from five sterile processed cheese blanks. A MS-based Electronic Nose (SMartNose) was used to detect volatiles in the mass-to-charge (m/z) range of 10 to 130 amu. Stepwise discriminant analyses followed by discriminant factor analyses on standardized data sets with and without five air samples found a group of mid-range masses that efficiently

separated cheeses by area of production along east-west axes. A few high-range masses were also important discriminators. Sensory panelists were likewise able to discriminate between cheeses produced in different areas of Sicily: western cheeses had stronger floral, fruity and mushroom/earthy aromas and eastern cheeses had stronger aroma intensities, butyric and spicy aromas. Eastern cheeses were also saltier, harder and less moist. Principal components analysis on the sensory data separated cheeses by area with an east-west axis on PC1 (58%) and a separation between northeastern and southeastern Sicily on PC2 (17%). Both EN and traditional sensory analysis found similar differences among cheeses. While EN technology is simpler and faster to use, especially if there are a lot of samples, the human nose is probably still superior in detecting subtle differences.

Key Words: Pecorino Siciliano, Electronic Nose, Sensory Analysis

545 Differences between milled curd and stirred curd Cheddar cheese manufactured with different culture/enzyme systems. S. Rehman^{*1}, N. Farkye¹, and M.A. Drake², ¹Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, ²Southeast Dairy Foods Research Center, North Carolina State University, Raleigh.

The quality of Cheddar cheese made by stirred or milled curd methods are presumably different. This study was undertaken to minimize quality differences in Cheddar cheese due to method of manufacture by evaluating the effects of culture and ripening temperature on Cheddar cheese. Three replicate experimental cheesemaking trials (by both milled and stirred curd methods) were conducted using specific culture systems supplied by four commercial culture companies. On each cheesemaking day, two 625 kg lots of milk were made into Cheddar cheese with one culture system by each method. Cheese curds in 18.2kg blocks were pressed overnight in a vacuum chamber with 24 mmHg for first 60 min. Cheeses were ripened at 2 or 8°C and sampled at intervals for starter and non-starter lactic acid bacteria (NSLAB), and proteolysis. Sensory analysis was done at 3, 6 and 9 months by a panel (n=6) and 12 industry graders. Growth of starter or NSLAB was not effected by the method of manufacture (P>0.01). Proteolysis and the sensory attributes diacetyl, sour and salty were influenced by method of manufacture. The culture system affected cell density of NSLAB and the sensory attributes cooked, whey, sulfur, brothy, milkfat, umami and bitter while only brothy flavor was influenced by storage temperature.

Key Words: Cheddar Cheese, Milled and Stirred Curd, Culture

546 Influence of brine concentration, brine temperature, and presalting on early gas defects in raw milk pasta filata cheese. C. Melilli^{*1}, D. M. Barbanò², M. Caccamo¹, M. A. Calvo¹, G. Schembari¹, and G. Licitra¹, ¹CoRFiLaC, Regione Siciliana, Ragusa, Italy, ²Northeast Dairy Food Research Center, Department of Food Science, Cornell University, Ithaca, NY.

Thirty one 3.8-kg experimental blocks of Ragusano cheese were made on each of 6 days. On days 1, 3, and 5 cheeses were not presalted while on days 2, 4, and 6 cheeses were presalted. One block was analyzed prior to brine salting. Blocks (15) were placed in 18% brine and the other 15 into saturated brine. For the 15 blocks within each of the two brine concentrations (BC), 5 blocks were placed in a brine at 12°C, 5 at 15°C, and 5 at 18°C. One block was removed from each brine tank after 1, 4, 8, 16, and 24 d, weighed, sampled, and analyzed for composition, coliform count, and gas production. Presalting the curd with 2% salt before stretching reduced the coliform count in the cheese by 1.41 log and made a major reduction in early gas formation. Gas production was measured by image analysis of cheese slices to determine the percent of the surface area of the slice occupied by gas holes. Across all treatments the largest reduction in gas formation (ca. 75%) was due to presalting. Reducing brine temperature (BT) had the second largest impact on reducing gas production, but did not reduce the coliform count in the cheese. Reducing BT from 18 to 12°C made a larger reduction in gas formation in cheeses that were not presalted (from 6.8 to 1.8% gas holes, respectively) than in cheeses that were presalted (from 1.9 to 0.5% gas holes, respectively). To achieve the same absolute level of gas production in the cheese that was not presalted, as was achieved by the combination of presalting and 18°C brine, the BT had to be lowered from 18 to 12°C. Reducing BC, while it improved salt penetration, did not have any impact on coliform count and had minimal impact on

reducing gas production. Reducing BC, while it improved salt penetration, did not have any impact on coliform count. BC did not affect gas production at BT of 12 and 15°C. The amount of gas holes were not different from 0 to 16 d but were higher at 24d in saturated brine at 18°C than in 18%B at 18°C.

Key Words: Early Gas, Coliform, Presalting

547 Direct acidification and cream homogenization for Mozzarella cheese manufacture. K. J. Ottman and L. E. Metzger^{*}, Department of Food Science and Nutrition, MN-SD Dairy Food Research Center, University of Minnesota, St. Paul.

The effect of direct acidification, cream homogenization and non-fat dry milk addition on Mozzarella cheese composition and functionality were determined. Four vats (16 kg of milk per vat) of cheese were made with no direct acidification (control), direct acidification with acetic acid (DA), direct acidification with acetic acid and homogenized cream (DH), and direct acidification with acetic acid, homogenized cream and addition of non-fat dry milk (DHNF). Cheese curd produced in the direct acidification treatments was stretched in a process cheese twin screw cooker to 70°C whereas the control was stretched by hand in a hot brine solution to a temperature of 60°C. Cheese manufacture was replicated three times on different days. The direct acidification treatments had a significantly (P<.05) lower calcium content as compared to the control. The DA treatment had significantly higher (P<.05) fat losses as compared to the control. However, when cream homogenization was used in conjunction with direct acidification (DH and DHNF), the cheese produced had a similar (P>.05) fat content and fat recovery as compared to the control. Non-fat dry milk addition (DHNF) resulted in the highest actual and adjusted yield. The control treatment had a significantly higher level of pH 4.6 and 12% TCA soluble nitrogen throughout 90 d of refrigerated storage as compared to the direct acidification treatments (DA, DH and DHNF), which remained relatively stable. The direct acidification treatments had less proteolysis due to the lack of starter culture and higher stretching temperature. The control had an increase in meltability during the first 30 d and then remained stable throughout refrigerated storage whereas the direct acidification treatments remained stable throughout storage. The DA treatment had the greatest meltability and the DHNF treatment had the least meltability at 30, 60, and 90 d of refrigerated storage. This study demonstrates that direct acidification in conjunction with cream homogenization and a high temperature during stretching can be used to produce Mozzarella cheese with targeted functionality immediately after manufacture and throughout 90 d of refrigerated storage.

548 Effects of 6 month extended frozen-storage on changes in organic acid profiles of plain soft and Monterey Jack goat milk cheeses. Y. W. Park^{*}, J. H. Lee, and I. C. Blackman, Fort Valley State University, Fort Valley, GA.

Maturation processes of cheeses are not well understood for most varieties because of the heterogenous nature of the product. Although organic acid composition is greatly related to the acceptability of goat milk cheeses, few reports are available on this premise. Three lots of plain soft (PS) goat cheeses were purchased, and 3 lots of Monterey Jack (MJ) goat cheeses were manufactured at the University dairy plant to study changes in organic acid profiles during 6 months of extended frozen and refrigerated storage. Each cheese variety was subdivided into 4 equal portions. One portion was stored at 4°C for 4 weeks (0, 14, 28 days) as the unfrozen control (UFC), and the other three subsamples were frozen (-20°C) and stored for 0, 3 and 6 months (FZC, 3FZ and 6FZ), then immediately thawed the next day at 4°C, followed by aging at 4°C for 4 wks. Organic acids were assayed using a HPLC (Hewlett Packard; LC-1100 Series) equipped with auto sampler and diode array UV detector. The column was reverse phase Hewlett Packard ODS Hypersil 5µm (125 X 4 mm), and solvent was 0.5% (wt/vol) (NH₄)₂HPO₄. Differences in organic acid contents between soft and MJ cheeses were significant (P<0.01 or 0.001) for all acids except citric and lactic acid. Lot effect was significant (P<0.01) for most of the known acids, indicating that some variations might have occurred in milk composition and manufacturing processes. Effects of storage treatments (UFC, FZC, 3FZ and 6FZ) were highly significant (P<0.01 or 0.001) for most organic acids, except for orotic and a few unidentified acids. Aging at 4°C for 4 weeks had little influence on all organic acids except butyric acid. Concentrations of butyric, lactic, propionic, tartaric and uric acids were significantly (P<0.01) elevated as the frozen-storage period advanced.

Although several organic acid levels were elevated in the goat cheeses, prolonged frozen-storage upto 6 months may be feasible because no apparent deterioration in sensory scores were observed in other companion studies.

Key Words: Goat Cheese, Frozen-Storage, Organic Acids

549 Interaction of emulsifying salts with milk proteins. R. Mizuno^{1,2} and J. A. Lucey², ¹*Food Research & Development Laboratory, Morinaga Milk Industry Co., Japan*, ²*Department of Food Science, University of Wisconsin, Madison*.

Emulsifying salts (ES) are used for process cheese production, however, it is not completely understood how ES influence the physical and chemical properties of process cheese. The purpose of this study was to understand the interactions between ES and milk proteins using a simple model system. In this system, milk protein concentrates (MPC) solution was used as the source of milk protein and the effects of addition of ES upon milk protein were estimated by measuring the area of acid-base titration curves, turbidities, and the amount of soluble calcium. Various concentrations (0 to 0.7% (w/w)) of ES (trisodium citrate or sodium phosphates (ortho-, pyro-, or poly-)) were added to MPC solution (5% (w/w) solids). The pH of all solution was adjusted to 5.8 using hydrochloric acid after addition of ES (to be in the typical pH range of process cheese). The area of the titration curves was measured using the acid-base buffering method to observe changes in the amount and type of colloidal calcium phosphates (CCP). Turbidity measurements were made at 600 nm and the amount of soluble calcium was determined by measuring the calcium concentration that was ultrafilterable. An increase in the concentration of trisodium citrate brought about a decrease in the buffering capacity contributed by CCP, a decrease in the turbidity, and an increase in the amount of soluble calcium. Orthophosphates had little effect on the titration curves, turbidity, and the amount of soluble calcium. With increasing addition of pyrophosphates, the buffering capacity, turbidity, and amount of soluble calcium decreased. With the addition of a small amount polyphosphates, the effects were similar to those of pyrophosphates but when excessive amounts were added, there was a shift in the pH where the peak of the titration curve caused by CCP occurred, and an increase in the amount of soluble calcium. These results suggest that each ES influences milk proteins with different mechanisms.

Key Words: Emulsifying Salt, Milk Protein, Colloidal Calcium Phosphates

550 Impact of type of concentrated sweet cream buttermilk on the manufacture and functionality of pizza cheese. T. Y. Lin¹, S. Govindasamy-Lucey², J. J. Jaeggi², C. J. Martinelli², M. E. Johnson², and J. A. Lucey¹, ¹*Department of Food Science, University of Wisconsin, Madison*, ²*Wisconsin Center for Dairy Research, University of Wisconsin, Madison*.

Sweet cream buttermilk (SCB), a by-product of buttermaking, is a rich source of phospholipids, which could assist in fat emulsification. Most SCB is sold concentrated and it is not clear how the different concentration processes affect the behavior of SCB as an ingredient in cheese. SCB was concentrated by cold (<7C) ultrafiltration (UF), cold reverse osmosis (RO) or evaporation (EVAP). A washed, stirred-curd cheese was manufactured from the three different types of concentrated SCB. Cheesemilks of CN:fat ratio of 1.1 and final CN content 2.7% were obtained by blending UF-SCB retentate (19.5% TS), RO-SCB retentate (22.0% TS) or EVAP-SCB retentate (37.6% TS) with partially-skimmed

milk. Control cheese was made with partially-skimmed milk (11.3% TS). Cheese functionality was assessed using dynamic low-amplitude oscillatory rheology (DLAOR), UW Melt Profiler (extent of flow after heating to 60C) and on pizza. Initial trials with SCB fortified cheeses resulted in 4% higher moisture (51-52%) than control cheese (46-47%). In subsequent trials procedures were altered to obtain similar moisture content in all cheeses. Fat recoveries in cheeses were lower with SCB fortified milks than with control milks. Nitrogen recoveries in cheeses made with control milks were slightly higher than in cheeses with RO-SCB and EVAP-SCB milks; but lower than UF-SCB milk cheeses. Total phospholipids recovered in SCB-cheeses (28-34%) were lower than control (42%). From DLAOR test, the loss tangent curves at temperatures > 40°C increased as cheese aged up to a month and were lower in SCB-cheeses than control. Extent of flow was higher for control cheese than SCB-cheese and as cheese ripened, it increased for all cheeses. TCA-soluble nitrogen levels were slightly lower in SCB fortified cheese than control. On baked pizza, UF-SCB fortified cheese had lowest amount of free oil but flavor attributes of all cheeses were similar. Addition of concentrated SCB to standardize cheesemilk for pizza cheese lowers free oil without adversely affecting functional properties of cheese but could increase cheese moisture, unless corrected.

Key Words: Sweet Cream Buttermilk, Pizza Cheese, Melt

551 Effect of fat content on rheological and melting properties of Mozzarella cheese. C. Udayarajan* and J. Lucey, *Department of Food Science, University of Wisconsin, Madison*.

Melting properties of Mozzarella cheese are influenced greatly by its chemical composition. The objective of this study was to evaluate the influence of various fat levels on rheological and melting properties of Mozzarella while maintaining similar moisture content. Mozzarella cheeses with low (30%), medium (40%) and high (50%) fat in dry matter (FDM) were manufactured. Cheeses properties were analyzed on day 2, 7, 14, 21 and 28. Rheological properties were studied using Fourier Transform Mechanical Spectroscopy (FTMS), which is a type of small amplitude oscillatory rheometry. Using FTMS the data for a wide range of frequencies (0.08-8 Hz) were collected in real time while cheese sample was heated over a temperature range from 10 to 90°C at 1°C/min. Storage modulus (*G'*) and loss modulus (*G''*) increased with frequency for all cheeses and the differences between frequencies were more evident at higher temperatures. Both *G'* and *G''* were lower with an increase in fat content and their values at high temperatures decreased with increasing cheese age. During heating all three cheeses exhibited a maximum in loss tangent (*Max_{tan}*) and the value of *Max_{tan}* decreased as the frequency increased. *Max_{tan}* increased with an increase in fat content and ripening period. Melting properties like extent of flow at 60°C and melt area were analyzed using UW Melt profiler and Schreiber test, respectively. Meltability improved as the fat content increased. Extent of flow increased for all cheeses from day 2 to 21 and then hardly changed. There was a significant correlation between extent of flow and *Max_{tan}*. Melt area was higher for medium and high FDM cheeses compared to low FDM cheese. Melt area increased with age for medium and high FDM cheeses up to day 14 and then declined. Melt area did not change during ripening for low FDM cheese. Rheological results correlated well with the pizza bake test in which the low FDM cheese blistered and blackened and did not flow. Excessively strong protein interactions in the high protein (low FDM) cheese were responsible for its poor meltability. Strategies are needed to reduce the strength of protein interactions if improved meltability is required.

Key Words: Mozzarella, Rheology, Melt

Extension Education - Animal Science

552 Beef development costs. W. Ellis*, *Southeast Missouri State University, Cape Girardeau*.

The objective of the study was to determine the cost of beef heifer development from weaning to her first parturition. The study was conducted at Southeast Missouri State University Farm. Data were obtained from thirty-one Angus or Angus cross heifers born in the fall of 2000. Heifers were weaned in April of 2001, bred in November of 2001, and calved in fall of 2002. Heifer development followed the guidelines of the Missouri Show-Me-Select Replacement Heifer Program, which is an educational program involving comprehensive guidelines for beef replacement heifer

development and marketing. Program development included pasture, feeds, labor, vaccinations, pre-breeding reproductive tract score, estrus synchronization, artificial insemination (AI), clean-up bull, pregnancy testing, and cost of open heifers. Mean weight and age (Mean SE) of heifers at weaning and at beginning of the breeding season were 203.7 ± 2.9 kg, 205.6 ± 3.2 days, 370.4 ± 4.9 kg, and 405.6 ± 3.2 days, respectively. Mean pre-breeding reproductive tract score was 4.9 ± .04 indicated 31/31 (100%) of the heifers reached puberty and cycling before breeding season. First AI service pregnancy rate following estrus synchronization treatment was 22/31 (71%) and pregnancy rate after

the breeding season (AI and clean-up) was 29/31 (94%). The cost of the development program was \$400.23 per beef heifer. The worthiness of this cost is acceptable based on heifer sale price from the Show-Me-Select sale. The average sale price per heifer for nine of the 29 pregnant was \$1125. The remaining 20 pregnant heifers were retained in the herd. The combination of the development cost and heifer value at weaning yields a cost of \$889.32. The net profit of the heifers was \$235.68 per heifer sold.

Key Words: Beef, Development, Cost

553 Elements influencing cattle buyers to participate in preconditioned certified calf sales. M. D. Corro*, D. Lalman, J. D. White, R.P. Wettemann, and J. P. Key, *Oklahoma State University, Stillwater.*

The Oklahoma Quality Beef Network (OQBN) was organized in 2001 with the primary objective of adding value to weaned calves and capturing a portion of this value for both the cattle producer and the cattle buyer. The OQBN provides a process verification system relative to management practices applied to beef calves around the time of weaning. The fundamental concept is that by reducing costs associated with sickness, improving animal performance; and improving beef product quality, additional value can be achieved in beef cattle production. Livestock market owners cooperate with producers by assembling OQBN process verified calves and marketing them in certified calf sales. Survey data were collected from OQBN participants during the fall of 2001 and 2002 to determine elements which influenced cattle buyers to participate in certified preconditioned calf sales. A total of 291 stakeholders that either bought or sold cattle through the OQBN during the fall of 2001 and 2002 were identified. One hundred eighteen stakeholders (40.5 %) responded to the survey. The chi-square test was used to evaluate differences between groups of stakeholders. Livestock market operators, Cooperative Extension and OCA meetings were the most frequent source of awareness for buyers regarding the OQBN program and sponsored auctions. The majority of buyers (86%) that responded to the survey purchased the cattle for their own operation. A total of 72% of buyers indicated they normally purchased more than 500 head annually. The majority (85%) of buyers in 2002 indicated that they had to treat less than 10% of the cattle they purchased, while 33% of 2001 buyers indicated less than 10% treatment or pull rate. The percentage of buyers paying a premium price of \$4 cwt. or more above the regular market, was greater ($p < 0.05$) in 2001 than in 2002. No statistical difference ($P > 0.05$) was found among the perceived premium price received by producers and the perceived premium price paid by buyers. The benefits related to preconditioned cattle, convenience, and other benefits were the main elements for buyers purchasing cattle in certified calf sales.

Key Words: Preconditioning, Certified Calf Sales, Beef Cattle

554 Selected management practices of beef cows on cow-calf operations in Oklahoma. M.D. Corro*, D. L. Lalman, K. Barnes, and J. L. Evans, *Oklahoma State University, Stillwater.*

A total of 3000 cow-calf operators were identified by the Oklahoma Cooperative Extension Services in the Northeast District of Oklahoma. A sample of 323 cow-calf operators participated in a study to describe selected management practices that may influence cow-calf operators to adopt preconditioning practices. Information was gathered on demographic characteristics preferred calving season, perceived return over costs needed for applying preconditioning management, perceived costs of running beef cows, perceived limiting factors for preconditioning practices and major obstacles to profitability. The chi-square test was used to evaluate differences between groups of cow-calf producers. A total of 69.7 % of the operators had more than 15 years in the beef business. A majority (68.5%) of operators had less than 100 cows. Only a portion (13 %) of cow-calf producers indicated they currently apply preconditioning practices. Almost half (49.3 %) of producers indicated they would accept less than \$30 profit per head for preconditioning. Similarly, half of the operators indicated they had \$350 annual costs for running a beef cow. Among the elements that limiting the use of preconditioning practices, 51.2 % of operators ranked time and labor as the major limiting factor for preconditioning; facilities (fences, pens, etc) were ranked as the second most limiting factor, and know-how as the third limiting factor. Collectively, these management practices, higher production costs, and lower market price were indicated as the major

obstacles for profitability that may contribute to a lower adoption of preconditioning practices among cow-calf operators.

Key Words: Beef Cattle, Management Practices, Preconditioning

555 Maximizing extension efforts by multi-county horse programs. O. F. Harper*, J. Hall, J. Goddard, J. Rhea, and B. Slinger, *University of Tennessee, Knoxville.*

In the fall of 2001, a major focus on Extension education adult horse programs was initiated in the Smoky Mountain Extension District, which encompasses 24 counties in Eastern Tennessee. In 2001, one multi-county adult horse program was conducted in the district. This was expanded to seven multi-county horse programs in 2002 and eight in 2003. Two new programs, Horse Ownership Course and a Horse Round Table, were initiated and additional programs expanded in two key metropolitan areas, the centers of program focus. Extension agents in the Knox-Metro area and upper East Tennessee and Southwest Virginia counties joined the horse specialist in forming leadership teams in coordinating the programs in these two metro-areas. The programs include Horse Management Courses, Horse Ownership Courses and Horse Round Tables. All programs are multi-county and the Horse Management and Horse Ownership Courses are fee-based programs. The Horse Ownership Courses provide 10-hours of continuing education meeting one-night per week (2 hours) for five weeks, focusing on basic topics of ownership: facilities, feeding, management, health care and selection. The Horse Management Courses are also one night for five weeks (10-hours of continuing education); however, topics are generated from exit-evaluations from the previous years attendees plus input from the Extension agent and horse specialist. Other major differences are the Ownership Courses have a limited enrollment of 30-35; whereas, Management Courses are limited only by available facilities. Ownership Courses are designed as a one-time course while participants are encouraged to attend the Management Courses each year. The Horse Round Table is a one night with five to six 15-20 minute current topic presentations are followed by a question and answer session. In the fall/winter of 2002/2003, 318 individuals attended seven programs. The average program rating was 4.7 out of 5 with 99 percent stating they would attend another Extension horse program and 99.7 percent would recommend these programs. Pre and post-test from six programs showed a 39 percent increase in knowledge.

Key Words: Horse, Multi-County Outreach, Extension Programs

556 Expanding extension horse programs by the internet. O. F. Harper* and E. L. Tipton, *University of Tennessee, Knoxville.*

New scientific information and technology transfer is the mission of the Extension Service. Rapid advance of the Internet provides an innovative and challenging methodology to reach new, broader and often diverse audiences. It provides an opportunity to showcase impacting research, field data and specific focused Extension programs. The web site highlights seven Extension species programs: Beef, Dairy, Horse, Poultry, Sheep and Swine, in addition to 4-H programs. The Department's horse web page (<http://animalscience.ag.utk.edu/horses/horse.htm>) has been used to augment, broaden awareness and provide articles while marketing new educational horse programs. The horse page begins with Hot Topics and Events. This area marquee: video releases, Extension Horse Course and a West Nile Virus (WNV) Information web page. The 4-H Horse Program, Publications and Educational Materials, News Letter (Tennessee Horse Express), Horse Links and Calendar of Events rounds out the directory. The occurrence of WNV promoted the posting of periodic reports of WNV positive horse and bird activity during the year and the development of an interactive state map showing the number of positive horses and birds by county. Listing of varied educational horse programs is a marketing initiative and industry promotional effort. This user-friendly site is easily navigated from current issues and programs to relevant educational materials. Web-based publications include 23 fact sheets and Horse Information Series which are categorized as Genetic, Health Care, Management, Nutrition or Reproduction. Articles appear in more than one category to assist one-time users. Reviews of Extension horse programs and activities aid in marketing future programs, documents the department's educational horse impact and provides recognition for involved Extension agents. E-mails, telephone calls and letter requesting additional information indicates the web page is viewed by

horse owners, breeders, agribusiness, government agencies and the general public. Agricultural/equine press usage of articles from the web site indicates the value of these materials and its easy and rapid access.

Key Words: Horse, Internet, Extension Programs

557 Holey Cow—The inside story of why cows eat grass—a model for youth agricultural education. D. J. R. Cherney*, B. Berggren-Thomas, and A. W. Bell, *Cornell University, Ithaca, NY.*

Less than 2% of the U.S. population is currently involved in agriculture and many young people have little or no experience with farm animals. We need young people to continue to chose agricultural careers, but also, as adult consumers, to make intelligent choices and policies about issues involving the use of animals for food and fiber. We have developed a program that begins with a PowerPoint slide show describing ruminant animals. The Powerpoint includes images of a variety of ruminant animals that the students may have seen on television or in zoos. We describe how a ruminant is able to use grass with the aid of slides and other props. The presentation is geared to the level and experience of the youth group. These groups range in age from 6 to 18 years and from no animal experience to farm youth. Because these audiences learn best from hands-on experiences, they are invited to handle a rumen-fistulated cow, offer her feed, and explore the rumen. The youth are given lab coats and gloves and can place their arm inside the cow. The program includes the use of a microscope for viewing rumen microflora and a feed demonstration. In this way, participants can see, feel and smell what we have talked about, reinforcing their learning experience. When appropriate, the program also includes discussion of possible careers in animal biology and production. Last year 10 demonstrations were conducted for approximately 350 young people and their chaperones. The program has Institutional Animal Care and Use Committee Approval. Many of the groups bring new students each year. The cow is a critical component of the success of this program.

Key Words: Agricultural Education, Youth

558 Healthy farms—healthy agriculture: A new approach to biosecurity education. J. M. Smith*, *University of Vermont, Burlington.*

The University of Vermont entered into a special cooperative agreement with the United States Department of Agriculture's Animal and Plant Health Inspection Service in 2002 to distribute biosecurity materials relevant to ruminant livestock production. The original objectives were to develop, produce, and distribute information on (1) biosecurity measures that all personnel, salespeople, consultants, and visitors should follow when entering farm animal premises and (2) measures to follow when bringing animals, especially those of unknown origins, onto existing farms. These objectives were modified during the planning process involving various stakeholders. The stakeholders helped identify our target audiences and the types of information they needed. We concluded that farm owners are responsible for the biosecurity measures practiced on their farms by themselves and their employees, as well as by the agri-service personnel, salespeople, and others who enter the premises. So the materials were designed to be distributed to and used by farmers. In addition to biosecurity procedures for people and

new or returning animals, we decided to cover measures to reduce the biosecurity risks posed by wildlife. The title was chosen so as to not be alarming. The main outputs of the project were a professionally-printed, 3-ring binder with about 100 pages of information, a compact disk of the same information adhered inside the back cover, and a web site (www.uvm.edu/~ascibios/) where the information was posted. Tabbed dividers were labeled introduction, assessment, new animals, visitors, wildlife, biosecure practices, diseases, and appendix. Our goal was a well-organized collection of existing information, reformatted to make it easy for farmers to understand and apply. Sixteen reviewers, who included veterinarians, extension faculty, agri-service personnel, and farmers, made comments on drafts of the materials. The finished binder was distributed to all ruminant and dairy farms listed with the Vermont Agency of Agriculture, Food, and Markets in fall of 2003. A video was also planned but not completed by the end of the one-year project period.

Key Words: Biosecurity, Extension

559 An environmental assessment tool for poultry farms developed as part of environmental management systems. P. H. Patterson*¹, L. E. Lanyon², and A. H. Mende³, ¹*Department of Poultry Science, The Pennsylvania State University, University Park,* ²*Department of Crop and Soil Sciences, The Pennsylvania State University, University Park,* ³*PennAg Industries Association, Harrisburg, PA.*

Environmental Management Systems (EMS) for the poultry industry address environmental policy with continuous improvement to ultimately achieve regulatory compliance and pollution prevention. As part of the 9-state Partnership for Livestock Environmental Management Systems project, a team of industry, government and university stakeholders developed an assessment tool for the commercial layer, broiler and turkey industries in Pennsylvania (PA). The goal of the tool was to set environmental priorities, to evaluate environmental protection measures, and to communicate and monitor environmental performance. It was adapted from national and existing PA Farm*A*Syst materials, and field-tested on 10 layer, 10 broiler and 10 turkey farms. Eleven priority areas were evaluated for risk on a scale from 1-low to 4-high risk including: drinking water supply, septic design and operation, run-off issues, mortality management, farm nutrient balance, emergency action planning and more. Example average scores for drinking water supply were: 1.7 layers, 1.7 broilers, 1.4 turkeys, however, the range of scores were 1-2.3, 1-4 and 1-4, respectively, indicating improvement opportunities. Other opportunities were identified for pest, odor and dust management (broilers), mortality management (turkeys) and farm nutrient balance (layers). Survey responses by producers indicated the tool was helpful to their operation, the experience raised awareness, 75% preferred the 3rd party assessment to self-assessment, and 1/3 were interested in pursuing an EMS. An important lesson from the pilot was that producers have little time and a concise, timely assessment was essential. The tool was effective in documenting performance and identifying opportunities. It has been proposed for adoption as the poultry component of PEACCE, a state-wide certificate program for environmental excellence and stewardship in animal agriculture.

Key Words: Poultry, Environmental Assessment, EMS

Forages and Pastures: Harvesting and Grazing Management of Forages

560 The effects of total non-structural carbohydrates (TNC) on voluntary intake of goats and digestibility of gamagrass (GG) harvested in the morning (AM) or afternoon (PM). A. Sauve*¹, G. Huntington¹, and J. Burns^{1,2}, ¹*North Carolina State University, Raleigh,* ²*USDA, ARS.*

The objective was to evaluate the differences in TNC of Iuka GG (*Tripasacum dactyloides L.*) harvested at 0530 (AM) or 1730 (PM), and to measure how TNC concentration and CP supplement affect the voluntary DMI and digestible DMI (DDMI) of GG field-cured and stored in square bales. Boer X Spanish wethers (24 ± 3 kg) were randomly assigned to supplement (SP, 31% CP, fed at 11% of DMI, 14 goats) or no supplement (14 goats). Within SP or no SP, goats were randomly assigned to a crossover design of AM GG (7 goats) or PM GG (7 goats). Goats were individually housed in metabolism crates with free access

to water and mineral blocks. They were fed twice daily, with SP being offered once a day 30 min before morning feedings. After a 7-d adaptation, voluntary intake (goats were fed 110% of previous days intake) was measured for 14 d, followed by a 4-d adjustment (to equalize DM offered between periods) and a 5-d digestion trial to measure DM digestibility (DMD). After Period 1 the goats were switched to their new diets, and the protocol was repeated. GG concentrations are g/kg DM and intakes are g/d. Means differ at $P < 0.03$. Compared to AM, the PM harvest had greater TNC (72.5 vs. 59.1), monosaccharides (37.3 vs. 27.5), and di- and polysaccharides (15.4 vs. 13.3). The DMD was greater for PM vs. AM (56.0 vs. 53.6%) and for SP vs no SP (57.0 vs. 52.7%). Crude protein (92) and starch (19.1) were similar ($P = 0.98$) for PM and AM. Compared to no SP, SP increased total DDMI (DMI times DMD from the digestion trial) during the voluntary intake phase (344 vs. 305) and

digestion trial (337 vs. 292). However, GG DMI was not affected ($P > 0.17$) by SP during the voluntary intake phase (531 vs. 571) or digestion trial (522 vs. 554). Voluntary GG DMI (552 vs. 551, $P < 0.89$) and voluntary total DDMI (331 vs. 318, $P < 0.15$) were similar for PM and AM; however, total DDMI during the digestion trial was greater for PM vs. AM (325 vs. 304). We conclude that PM GG had a greater DMD and DDMI than AM GG due to increased TNC and not due to differences in intake by the goats. Supplementation had small effects on DMI and DMD of GG.

Key Words: Gamagrass, Meat Goats, Carbohydrates

561 Afternoon harvest increases readily fermentable carbohydrate (CHO) concentration and voluntary intake of gamagrass (GG) and switchgrass (SG) baleage fed to beef steers. G. Huntington*¹ and J. Burns^{1,2}, ¹North Carolina State University, Raleigh, ²USDA,ARS.

Our objective was to determine if AM (0600) vs. PM (1800) harvest affects CHO composition and voluntary intake of GG or SG stored as baleage. Iuka GG (*Tripsacum dactyloides* L.) and Alamo SG (*Panicum virgatum* L.) were direct-cut and stored as baleage in round bales wrapped in plastic. Black steers (260 ± 16 kg BW) were assigned (5 steers per treatment) to GG/AM harvest, GG/PM harvest, SG/AM harvest, or SG/PM harvest. Steers were group-housed in covered, outdoor pens with individual feeding gates. After adaptation to the facility and 14 d standardization, ad libitum intake was measured for 21d (7 d adjustment and 14 d intake estimate) followed by a 5-d digestion trial in indoor digestion crates. Silage concentrations are g/kg DM. Means differ at ($P < 0.05$). Compared to AM harvest, PM harvest had more starch (9.3 vs. 4.7), total nonstructural CHO (30 vs. 19), and monosaccharides (17 vs. 11). Compared to AM harvest, PM harvest had less acetate (13 vs. 18) and propionate (0.29 vs. 0.82), and tended ($P = 0.12$) to have less lactate (2.9 vs. 3.5) and butyrate (3.9 vs. 5.1). Compared to SG, GG had more starch (9.4 vs. 4.7), total nonstructural CHO (34 vs. 15), and monosaccharides (21 vs. 7.4). Compared to GG, SG had higher pH (5.79 vs. 5.32) and more ethanol (27 vs. 19), acetate (19 vs. 12), propionate (1.11 vs. 0.00), and butyrate (8.4 vs. 0.6), but less DM (242 vs. 324 g/kg silage), and DM concentrations of CP (97 vs. 114) and lactate (1.6 vs. 4.8). Daily DMI (2.16 vs. 1.83 % BW) and digestible DMI (1.15 vs. 0.95 % BW) were greater for PM vs. AM harvest. Serum urea N concentrations at the end of the intake phase were greater for AM (3.91 mM) than for PM harvest (2.31 mM) and tended ($P < 0.09$) to be greater for GG (3.51 mM) than for SG (2.71 mM). We conclude that increased soluble CHO content of these grasses stored as baleage caused increased voluntary intake by beef steers. Decreased serum urea N is consistent with improved retention of dietary N for PM vs. AM harvest.

Key Words: Gamagrass, Switchgrass, Beef Steers

562 Digestion characteristics of perennial ryegrass (*Lolium perenne* L.) at different stages of maturity. A. V. Chaves¹, G. C. Waghorn*², and I. M. Brookes¹, ¹Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand, ²Dexel Limited, Hamilton, New Zealand.

In vitro and *in sacco* digestion offers a rapid and inexpensive method for evaluating nutritive value of ruminant feedstuffs. The hypothesis to be tested here was that ryegrass maturation will alter rates of degradation and products of digestion and these changes will be affected by initial cutting dates (ICD) of the sward. Ryegrass pasture was mown at three dates in Spring and samples of 2 kg were harvested at 7-14 day intervals for chemical analyses and *in vitro* and *in sacco* incubations by cutting to 5 cm above soil level. An important aspect of this experiment was the use of the fresh mincing procedure to provide material for *in vitro* and *in sacco* incubations which mimicked cow digesta. Comparison of ICD showed minor effects on the rate of change in chemical composition. This affected fibre but not CP or NSC content. Protein degradation was not affected by maturation (mean $k=0.12h^{-1} \pm 0.08$), but a higher proportion was released into the soluble (A) fraction with mature grass (A=52 to 72%). This appeared to indicate more extensive cell rupture of mature grass and is likely to reflect the *in vivo* situation where more extensive chewing is needed to swallow mature, compared to succulent forages. In contrast to protein, fibre degradation rate was halved as ryegrass matured ($k=0.14$ to $0.03h^{-1}$), probably as a result of cross linkages between fibre components and lignification. Estimated

ME values for ryegrass were reduced from about 12.8 to 8.8 MJ/kg DM as ryegrass became mature. The ammonia production *in vitro* was a function of grass CP content, extent of release into the soluble fraction and microbial utilisation. One effect of maturation was a brief period of ammonia surplus followed by insufficiency for microbial growth, but the rate and amounts of VFA produced were not affected by forage CP content or ammonia concentration. Maturation had little effect on proportions of VFA. The hypothesis was proven in part; maturation did alter rates of degradation but products of digestion were less affected by maturation and the proportion of N degraded was similar for all maturities.

Key Words: Forage Maturity, Ryegrass, Nutritive Value

563 Effects of beef cow grazing management on sediment and phosphorus losses from smooth brome grass pastures. M. Haan*¹, J. Russell¹, W. Powers¹, S. Mickelson², R. Schultz³, and J. Kovar⁴, ¹Department of Animal Science, Iowa State University, Ames, ²Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, ³Department of Natural Resource and Environmental Management, Iowa State University, Ames, ⁴USDA-National Soil Tilth Laboratory, Ames, IA.

To determine the impacts of grazing management on phosphorus (P) and sediment loss to surface waters five-pasture management systems were evaluated. For 3 yr, three smooth brome grass pastures with slopes of up to 15° were divided into five 0.4-ha paddocks that were grazed by Angus cows (mean BW 632 kg). Grazing treatments included: an ungrazed control (U), summer hay harvest with winter stockpile grazing to a residual sward height of 5 cm (HS), continuous stocking to a residual sward height of 5 cm (5C), rotational stocking to a residual sward height of 5 cm (5R), and rotational stocking to a residual sward height of 10 cm (10R). In the late spring, mid-summer, autumn and early the subsequent spring of each year, rainfall simulations were conducted at 6 sites within each paddock, 3 at high slopes (7.5 to 15.0°) and 3 at low slopes (0 to 7.5°). Rainfall simulators dripped at a rate of 7.1 cm/hour over a 0.5-m² area for a period of 1.5 hours. Runoff was collected and analyzed for total sediment, total P, and total soluble P. Simultaneous to each rainfall simulation, measurements were taken of ground cover, penetration resistance, surface roughness, slope, soil P, soil moisture, sward height and forage mass. There was no difference in the amount of sediment in runoff across treatments. Of the variables measured, amount of sediment in the runoff was most highly correlated with percent ground cover ($r^2 = 0.16$). The 5R and 5C treatments contributed the greatest amount of total and soluble P ($p < 0.05$) to runoff, the 10R and HS treatments were intermediate, and the U treatment contributed the smallest amounts. High slope areas had greater surface runoff ($p < 0.05$) and greater sediment flow ($p < 0.05$) than did low slope areas. Forage management practices that leave greater forage residue on the pasture will reduce the amount of P potentially lost to surface waters in runoff. Pastures with high slopes are more sensitive to losses of sediment in runoff and may need to be stocked less intensively than pastures with low slopes.

Key Words: Grazing, Phosphorus, Water Quality

564 Apparent nutrient digestibility and ruminal alterations in beef steers consuming bermudagrass hay and supplemented with soybean hulls and/or corn. J. C. Henley*, A. I. Orr, and B. J. Rude, Mississippi State University, Mississippi State.

Six ruminally fistulated steers (initial BW = 266 ± 36.9 kg) were utilized in a digestion trial to evaluate the performance of steers consuming soybean hulls and/or corn while consuming bermudagrass hay. The steers were randomly allotted to one of three supplement groups: 1) soybean hulls (SBH); 2) 75% SBH + 25% corn (MIX); 3) corn (CORN). There were three collection periods of five days each. Prior to each 5-day collection, steers were adapted to their diets for 14 days, and were adapted to their individual stalls for an additional three days. Steers were housed in stalls for ten days per period (3 day adaptation, 5 day collection, 2 day in situ collection). All steers were fed their respective supplement at 1.5% BW at approximately 0800 each day and had ad libitum access to bermudagrass hay throughout the trial. There were no differences ($P > 0.05$) among treatments for dry matter, organic matter, or crude protein apparent digestibilities. However, steers consuming SBH and MIX had greater ($P < 0.05$) apparent digestibility of NDF (64.9 and

62.7%, respectively), ADF (65.4 and 63.2%, respectively), and hemicellulose (64.0 and 61.8%, respectively) compared to steers fed corn (51.9, 48.7, and 55.0%, respectively). No differences ($P > 0.05$) were found for total VFA or individual VFA concentrations among treatments. However, isobutyrate and isovalerate as a percentage of total VFA decreased ($P < 0.05$) with time after steers consumed their supplement. Valerate concentrations increased ($P < 0.05$) for approximately 6 hours after consuming supplements, and then decreased by 8 hours post consumption. Ruminal pH decreased ($P < 0.05$) from 6.93, 6.85, and 6.80 for CORN, SBH, and MIX, respectively to 6.30, 6.11, and 6.05, respectively. Supplementing steers with soybean hulls was not affected by addition of corn. However, supplementing with corn decreased fiber digestion. Use of soybean hulls as a supplement may improve animal fiber utilization compared to corn only when consuming hay.

Key Words: Soybean Hulls, Supplementation, Digestibility

565 Evaluation of different backgrounding programs for weaned beef calves. K. H. Hunter*, A. M. M. Shank, R. K. Shanklin, W. S. Swecker, J. P. Fontenot, G. Scaglia, and C. L. Pickworth, *Virginia Polytechnic Institute and State University, Blacksburg.*

Sixteen trials were conducted during 4 yr with 716 animals (552 steers and 164 heifers) (approximately 200 kg) to evaluate the effects of various regimens on performance and health during the backgrounding period (42 d) from weaning to stockering. Thirteen trials were conducted on pasture and three in drylot. All trials had a minimum of two replicates. Grazing trials were on stockpiled fescue-based pastures, and fescue hay was fed in the drylot trials. Grazing calves were fed different supplements with CP levels of 15, 16, 17.4, and 30% at rates of 0, 0.5, and 1.0% BW in different trials. Supplements included corn + SBM, soy hulls + SBM, corn gluten feed + soy hulls, alfalfa pellets, and a 50% hay mixture. Data for all trials were analyzed using the GLM procedure for analysis of variance for a completely randomized block design. Tukey's one way analysis of variance test was used to compare treatment and forage type effects and interactions. Usually, supplemented calves had higher ADG ($P < 0.05$) than unsupplemented calves. Similar ADG were observed when supplementation was provided at 0.5 and 1.0% BW ($P > 0.05$), suggesting that supplementation of calves at more than 0.5% BW is not advantageous. Similar gains were observed across all grazing trials with supplementation at 15, 16, 17.4, and 30% CP levels. Cattle supplemented with by-product feedstuffs (corn gluten feed + soy hulls and soy hulls + SBM) performed comparably to those supplemented with corn + SBM ($P > 0.05$). There were no differences in ADG between unsupplemented animals grazing either fescue pastures or fescue-alfalfa pastures. In drylot, animals supplemented with concentrate had higher ADG ($P < 0.05$) than unsupplemented animals. Low levels of protein supplementation improves performance of calves grazing stockpiled forage.

Key Words: Beef Cattle, Forages, Backgrounding

566 Impact of stocking rate and stocking strategy on gain per animal and gain per hectare of steers grazing rotational or continuous stocked rye-ryegrass pasture. J.J. Cleere*², F.M. Rouquette, Jr.¹, and G.M. Clary^{2, 1} *Texas Agricultural Experiment Station, Overton, 2Texas Cooperative Extension, Overton.*

Selecting appropriate stocking rates for winter annual pastures used for stocker cattle requires knowledge about the environment and forage growth attributes as well as management experience. Sod-seeded Maton rye and TAM 90 annual ryegrass pastures were grazed by Bonsmara x Beefmaster steers from December 18, 2002 to May 14, 2003 to quantify effects of stocking rate (SR), stocking method (SM), and stocking strategy (SS) on gain per animal and gain per hectare. Replicate pastures ($n = 2$) with ($n = 4$) steers each were used for each of the following treatments: 1) Stocking Rates; Low (LO, 2.5-238 kg steers/ha initially) and Medium (ME, 4.9-238 kg steers/ha initially). 2) Stocking Methods; Continuous (CN) and eight-paddock Rotation (RT, 2-d residence and 14-d rest). 3) Stocking Strategies; Fixed SR (FX, SR was fixed during the entire grazing period) and Variable SR (VR, initial SR were fixed until early March and then both LO and ME SR were increased to 7.4 hd/ha until termination). Animal ADG ranged from 1.22 to 1.28 kg/d for all low stocked pastures with no differences across SM or SS. Effects of stocking treatments on ADG became more apparent at ME stocking rate with the RTVR exhibiting 0.17 kg lower ADG (P

$= 0.02$) than the CNFX steers (CNFX = 1.18, CNVR = 1.14, RTFX = 1.05, and RTVR = 1.01 kg/d). The slight decline in ADG with VR strategy compared to FX was likely due to reduced forage availability in late spring. Differences in gain per animal were not detected between FX and VR at any one stocking rate with the exception of a difference in the ME-CNFX and ME-RTVR (152 vs 129 kg; $P = 0.02$). This may indicate that increased stocking via VR strategy in early March increased forage utilization with little negative impact on gain per animal. Gain per hectare ranged from 426 kg/ha on the LO-FX for both CN and RT to 884 kg/ha on ME-CNVR and 853 kg/ha on LO-CNVR. The opportunity to increase stocking rate on the rye-ryegrass pastures during spring increased forage growth can double the gain per hectare.

Key Words: Stocking Rate, Pasture, Animal Gain

567 Accuracy of intake measurements for cows grazing grass/legume pastures using the alkane marker technique. G. C. Waghorn*, S. L. Woodward, and D. A. Clark, *Dexcel Limited, Hamilton, New Zealand.*

Measurement of feed intakes of individual cows grazing perennial ryegrass (*Lolium perenne* L.) based pastures in New Zealand has favored use of alkane markers, in part because forage digestibility is not required for intake calculation. Estimates of DMI are based on recovery of odd chain length (C31 and C33) plant cuticular waxes (alkanes) in conjunction with twice daily administration of a synthetic even chain (C32) alkane marker. However some researchers have expressed concern over the accuracy of intake estimates. Implicit in this methodology is an equal recovery of all alkanes used in calculations of intake. Results of indoor trials with lactating cows and some supporting data from sheep are presented to demonstrate unequal recoveries of individual alkanes from faeces. Intake calculations presented here use pasture C31 and twice daily doses of C32 to estimate intakes. In a trial with 16 cows fed pasture and given a C32 marker, mean actual daily DM intake (y) $10.7 \text{ kg} \pm 1.09$ (mean \pm SD) was lower than predicted from alkanes (x) $11.2 \text{ kg} \pm 1.37$; where $y = 0.66x + 3.28$, $r^2=0.68$. The mean actual daily DM intake (y) of 15 cows in a separate trial (Trial 2) fed fresh pasture indoors with total faecal collection was $12.0 \text{ kg} \pm 1.19$ compared to predicted (x) values of $10.35 \text{ kg} \pm 1.06$; where $y = 0.77x + 1.15$; $r^2=0.75$). Recovery (% of intake) of C31, C32 and C33 from total collection of faeces in Trial 2 differed, averaging 89 ± 10.5 , 101 ± 10.6 and 97 ± 15.2 respectively. Comparable values from total collection of faeces from separate groups of six sheep were 92 ± 7.1 , 80 ± 6.6 and 83 ± 8.1 for pasture diets; 100 ± 7.5 , 106 ± 10.3 and 90 ± 9.2 for alfalfa diets and 73 ± 12.5 , 95 ± 14.8 and 57 ± 12.3 for white clover diets. The differences between faecal recovery of specific alkanes preclude an accurate prediction of intake and the standard deviations demonstrate large variations in recovery between animals. Inconsistent and contrasting alkane recovery will limit their use for estimating intakes of cattle grazing pastures.

Key Words: Alkane Markers, Pasture, Intake

568 Developing consistent relationships among fiber fractions for uniform alfalfa hay quality guidelines. D. R. Mertens*¹ and J. E. Getz^{2, 1} *US Dairy Forage Research Center, Madison, WI, 2USDA-Agricultural Marketing Service, Moses Lake, WA.*

Objective and uniform hay quality guidelines for market reporters are essential to ensure that hay prices are reported accurately, i.e., Good quality hay should be similar throughout the US. Our goals were to determine if relationships between ADF and NDF are consistent enough among laboratories from different regions of the US to derive a uniform equation. Fiber concentrations of alfalfa were obtained from laboratories in 15 states (ST), which provided a full range of values. To obtain a data set that was balanced, values were ranked by ADF and every nth sample was selected to obtain 40 to 50 samples per ST ($n = 625$). Residuals $< 3 \times \text{RMSE}$ of regression were removed as outliers ($n = 5$). The GLM Model: $Y = ST + b \cdot (X \cdot ST)$ for $Y = \text{ADF}$ with $X = \text{NDF}$ and $Y = \text{NDF}$ with $X = \text{ADF}$ was used to identify the ST with median geometric slope. Slopes of other ST were compared to the median and those ST not different ($P > .05$) were identified and used to generate pooled slopes. All ST with different slopes were compared to the pooled slope. Only one ST (CO) had slopes of ADF on NDF and NDF on ADF that differed ($P < .05$) from pooled slopes and this data was removed. The ST with

the median intercept was identified using the pooled slopes and compared to all other ST intercepts. Seven ST were not different ($P > .05$) from the median intercept with an average geometric intercept (GI) of 0.20 (AZ, CA, KA, MN, OR, PA, WA). Three ST had a higher average GI of 1.00 (UT, ID, NE), two ST had a lower GI of 0.95 (IL, NY) and two ST had the lowest GI of 3.08. Average GI weighted for the observations in each group was .19. The slope of ADF versus NDF appears constant throughout the US and variation in intercepts is more likely related to laboratory differences rather than to regional differences in alfalfa. In conclusion, it is possible to identify a geometric relationship between ADF and NDF that can be used to develop uniform alfalfa hay quality guidelines for the US: $ADF = -.19 + .80 \times NDF$; $n=605$, $R^2=.90$, and $RMSE=1.7$.

Key Words: Fiber, Forage Quality, Alfalfa

569 Effects of purified fiber energy supplementation on digestion and ruminal parameters of steers fed cool season grass hay. H. M. Blalock* and C. J. Richards, *The University of Tennessee, Knoxville.*

Six ruminally and duodenally cannulated steers were arranged in a replicated 3 x 3 Latin square. Steers had free choice access to cool season grass hay and were supplemented with 0 (NO), 0.25 (LO) or 0.50% (HI) BW of purified fiber (60% solka floc, 40% oat fiber) prior to AM hay

feeding. Periods were 18 d. On d 7 to 17, steers were intra-ruminally dosed with Cr_2O_3 followed by total fecal collection from d 12 to 17 and duodenal digesta sampling at 10 hr intervals on d 13 to 17. On d 17, Co-EDTA was ruminally dosed and rumen fluid collected at 0, 3, 6, 9, 12 and 24 hr post-dosing. On d 18, ruminal contents were evacuated, weighed and subsamples retained for bacterial separation. Forage intake and total N intake were not affected by supplementation. Total intake of DM, NDF, ADF and OM were increased ($P < 0.05$) with increased supplementation. Quantities and percentages of total tract DM, NDF, ADF and OM digestion were increased ($P < 0.05$) by supplementation. Ruminal and total tract nitrogen digestion were not affected by supplementation. Ruminal acetate and propionate concentrations were not affected ($P > 0.10$) while butyrate concentrations increased ($P < 0.01$) with supplementation. Isobutyrate, valerate and isovalerate concentrations decreased ($P < 0.01$) with supplementation. However, isobutyrate was not different between HI and LO. Ruminal pH was greatest ($P < 0.01$) for HI. Ruminal NH_3-N concentrations were decreased ($P < 0.01$) by supplementation. A TRT x Time interaction existed ($P < 0.01$) for NH_3-N due to the concentration of NO remaining relatively constant throughout the 24 hr period. Total N flow at the duodenum was not affected by supplementation. This data indicates that supplementing steers consuming cool season grass hay with fibrous energy can increase ruminal and total tract fiber digestion without affecting forage intake.

Key Words: Fiber, Digestion, Ruminant

Nonruminant Nutrition: Amino Acids

570 The optimal true ileal digestible lysine and total sulfur amino acid requirement for nursery pigs between 10 and 20 kg. J. D. Schneider*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, J. M. DeRouchey, C. W. Hastad, N. A. Lenehan, N. Z. Frantz, B. W. James, K. R. Lawrence, C. N. Groesbeck, R. O. Gottlob, and M. G. Young, *Kansas State University, Manhattan.*

An experiment involving 360 pigs (avg BW = 10.3 kg) was conducted to determine the appropriate true ileal digestible (TID) lysine and total sulfur amino acid (TSAA) requirement of nursery pigs, and consequently to determine the optimal TSAA:lysine ratio. This trial was organized as a combination of two separate experiments with one set of diets consisting of five treatments with increasing TID lysine (0.9, 1.0, 1.1, 1.2, and 1.3%) and the second set of diets consisting of five treatments with increasing TID TSAA (0.56, 0.62, 0.68, 0.74, and 0.81%). The highest level of both lysine and TSAA (1.3 and 0.81%, respectively) served as a positive control and this diet was combined as one treatment to give a total of nine treatments. Pigs were randomly allotted to 8 replications with 5 pigs per pen based on BW. Average daily gain increased (linear, $P < 0.01$), while ADFI decreased (linear, $P < 0.06$) to 1.3% TID lysine. Increasing TID lysine from 0.9 to 1.3% also improved (linear, $P < 0.01$; and quadratic $P < 0.05$, respectively) gain:feed. Increasing TID TSAA from 0.56 to 0.81% increased (linear, $P < 0.02$) ADG and improved (linear, $P < 0.01$) gain:feed. Regression analysis of the response surface resulted in an estimated TID TSAA to lysine ratio ranging from 55 to 61% for ADG and 57 to 61% for gain/feed.

Item	TID Lysine, %					SED	Linear	Quadratic
	0.9	1.0	1.1	1.2	1.3			
ADG, g	494	524	525	519	549	17.306	0.01	0.51
ADFI, g	901	881	872	842	865	36.733	0.06	0.34
Gain/Feed	0.55	0.59	0.61	0.62	0.63	0.012	0.01	0.05
Item	TID TSAA, %					SED	Linear	Quadratic
	0.56	0.62	0.68	0.74	0.81			
ADG, g	514	528	545	540	549	17.306	0.02	0.40
ADFI, g	878	868	881	867	865	36.733	0.66	0.88
Gain/Feed	0.59	0.61	0.62	0.62	0.63	0.012	0.01	0.34

Key Words: Total Sulfur Amino Acids, Lysine, Nursery Pigs

571 The optimal true ileal digestible lysine and threonine requirement for nursery pigs between 10 and 20 kg. N. A. Lenehan¹, M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, J. L. Nelssen¹, J. L. Usry², J. M. DeRouchey¹, and N. Z. Frantz*¹, ¹*Kansas State University, Manhattan*, ²*Ajinomoto Heartland LLC, Chicago, IL.*

A total of 360 pigs (Genetiporc; initially 10.7 kg and 34 d of age) were used in a 17-d growth assay. This trial was conducted as a combination of two separate trials in order to simultaneously examine both the true ileal digestible (TID) lysine and threonine requirements, and determine the appropriate threonine to lysine ratio. The first part of the trial consisted of five treatments with increasing TID lysine (0.9, 1.0, 1.1, 1.2, and 1.3%). The second part consisted of five treatments with increasing TID threonine (0.60, 0.66, 0.73, 0.79, and 0.85%). The highest level of both lysine and threonine (1.3 and 0.85%, respectively) served as a positive control and this diet was combined as one treatment to give a total of nine treatments. There were 8 replications with 5 pigs per pen. Both ADG and gain/feed (G/F) increased (quadratic, $P < 0.02$) to 1.2% TID lysine. For threonine, ADG (linear, $P < 0.03$) and G/F (quadratic, $P < 0.04$) increased to 0.79% TID threonine. Using 0.79% TID threonine and 1.2% TID lysine as the requirements yields a TID threonine to lysine ratio of 66% for both ADG and G/F. In summary, these results suggest a TID threonine to lysine ratio of approximately 66% for 10 to 20 kg pigs.

Item	TID Lysine, %					SED	Linear	Quadratic
	0.9	1.0	1.1	1.2	1.3			
ADG, g	532	541	587	599	582	19	< 0.01	0.02
ADFI, g	918	870	917	923	896	35	0.81	1.00
Gain/feed	0.58	0.62	0.64	0.65	0.65	0.01	< 0.01	< 0.01
Item	TID Threonine, %					SED	Linear	Quadratic
	0.60	0.66	0.73	0.79	0.85			
ADG, g	563	573	577	603	582	19	0.03	0.26
ADFI, g	924	900	897	923	896	35	0.45	0.64
Gain/feed	0.61	0.64	0.64	0.65	0.65	0.01	< 0.01	0.04

Key Words: Threonine, Lysine, Nursery Pigs

572 Assessment of the methionine requirement of pigs in the weight range 11 to 20 kg. Patrick B. Lynch^{*1}, Meike Rademacher², and Peadar G. Lawlor¹, ¹Teagasc, Moorepark, Fermoy, Co. Cork, Ireland, ²Degussa AG., Feed Additives, Hanau, Germany.

The objective of this trial was to determine the optimum ratio of Methionine (Met) to Lysine (Lys) for nursery pigs in the weight range 11 to 23 kg. A total of 192 pigs were used, with a pair of pigs of the same sex penned together (n = 96 pairs) as the experimental unit in a randomized complete block design. Pigs were fed a commercial starter diet for 11 d after weaning at 26 to 28 d of age and fed the test diets for 24 d. The basal diet contained (g/kg): wheat, 231; barley, 120; heated full fat soybeans, 200; field peas, 240; corn starch, 120; soy oil, 25; L-Lys HCl, 3.5; L-threonine, 2.0; L-tryptophan, 0.5; L-valine, 0.5; L-isoleucine, 0.5; minerals and vitamins, 57. The digestible energy content of the diet was 14.9 MJ/kg, crude protein was 166 g/kg, total Lys was 12.0 g/kg, and true ileal digestible (TID) Lys was 10.0 g/kg. The basal diet (2.2 g/kg total Met) was supplemented with DL-Met in increments of 0.4 g/kg to give seven diets ranging from 2.2 to 4.6 g/kg total Met. The ratio of total Met:total Lys varied from 0.183 to 0.383 and TID Met:TID Lys from 0.17 to 0.37. Total sulphur amino acids:Lys ranged from 0.41 to 0.61. Met supplementation increased the average daily feed intake (748, 734, 775, 840, 775, 829, and 707 g/d; quadratic, P < 0.01) and average daily gain (297, 372, 453, 457, 507, 515, and 459 g/d; linear, P < 0.01; quadratic, P < 0.01) and improved feed to gain ratio (2.55, 2.00, 1.74, 1.75, 1.54, 1.60, and 1.55; linear, P < 0.01; quadratic, P < 0.01). Exponential response curves were fitted and showed the optimum level of Met (95% of the asymptote) to be 4.1 g/kg for daily gain and 3.7 g/kg for feed:gain. It is concluded that the optimum ratio of Met:Lys is 0.31 for feed:gain and 0.34 for average daily gain.

Key Words: Nursery Pig, Methionine, Lysine

573 Evaluation of the true ileal digestible (TID) lysine requirement for 11 to 29 kg pigs. S. X. Fu^{*1}, A. M. Gaines¹, B. W. Ratliff¹, P. Srichana¹, G. L. Allee¹, and J. L. Ustry², ¹University of Missouri, Columbia, ²Ajinomoto Heartland LLC, Chicago, IL.

The objective of this research was to evaluate the true ileal digestible (TID) lysine requirement for 11 to 29 kg pigs. For this experiment, a total of 769 pigs (TR-4 × C22; 11.1 ± 0.2 kg) were allotted to one of six dietary treatments in a completely randomized design with 6 replicate pens/treatment. Dietary treatments included six TID lysine concentrations of 1.05, 1.14, 1.23, 1.32, 1.41, and 1.50%. Diets were formulated to be isocaloric and contained the same amount of soybean meal (34.25%). The dietary lysine content was increased by adding L-lysine-HCl with additional synthetic amino acids supplied as necessary to meet the minimum amino acid profile. Growth performance data were collected for 28 d. Body weights and feed intakes were recorded on d 0, 14, and 28. From d 0 to 14, increasing dietary lysine increased (linear, P < 0.01) ADG (505, 523, 546, 556, 554, and 550 g/d) and improved (linear, P < 0.001; quadratic, P = 0.01) G/F (0.631, 0.674, 0.691, 0.705, 0.710, and 0.711). At d 14, pigs were weighing an average of 19 kg. From d 0 to 28, increasing dietary lysine improved (linear, P = 0.03) ADG (614, 624, 633, 646, 639, and 646 g/d) and improved (linear, P < 0.001; quadratic, P = 0.01) G/F (0.621, 0.651, 0.657, 0.676, 0.670, and 0.669). At d 28, pigs were weighing an average of 29.0 kg. Based on the biological and economic data, the TID lysine level that maximized return over feed cost was 1.32%, regardless of weight range (11 to 19 or 11 to 29 kg). Results from this experiment indicate that the late nursery pig diet should contain at least 1.32% TID lysine.

Key Words: Lysine, Pigs, Growth

574 Estimation of the true ileal digestible sulfur amino acid requirement for nursery pigs weighing 13 to 25 kilograms by using Alimet[®] feed supplement. A. M. Gaines¹, G. F. Yi^{*2}, B. W. Ratliff¹, P. Srichana¹, G. L. Allee¹, C. D. Knight², and K. R. Perryman², ¹University of Missouri, Columbia, ²Novus International, Inc., St. Louis, MO.

The objective of this research was to estimate the true ileal digestible (TID) sulfur amino acid (SAA) requirement of 13 to 25 kg pigs reared under commercial conditions. A total of 1,303 pigs (TR-4 × C22; 12.7 ± 0.1 kg) were allotted to one of five dietary treatments in a randomized complete block design with twelve replicate pens (22 pigs/pen) per

treatment. Dietary treatments included five TID SAA levels that corresponded to concentrations of 0.63, 0.70, 0.77, 0.83, and 0.90%, respectively. Experimental diets were corn-soybean meal based and formulated to contain 1.40% TID lysine. Dietary SAA content was increased by adding Alimet[®] feed supplement (88% L-methionine activity) at concentrations of 0.00, 0.08, 0.15, 0.23, and 0.31%, respectively. Increasing dietary TID SAA increased (linear, P < 0.07; quadratic, P < 0.01) ADG (586, 611, 620, 604, and 608 g/d) and improved (linear, P < 0.001; quadratic, P < 0.01) G/F (0.638, 0.667, 0.676, 0.688, and 0.687). Based on the biological and economic data, the TID SAA that maximized return over feed cost was 0.77%. Using the relatively conservative two-slope broken line method, the TID SAA requirement was estimated to be 0.73 and 0.80% for ADG and G/F, respectively. These values were then used to determine the point at which the quadratic curve intersected the plateau of the broken line, which provided another objective estimate of the SAA requirement. The point at which the quadratic curve first intersected the plateau of the broken line occurred at 0.77 and 0.83% for ADG and G/F, respectively. Based on the current study, it can be concluded that the TID SAA requirement for 13-25 kg pigs are 0.73-0.77% for maximal ADG and 0.80-0.83% for optimal feed efficiency. [®]ALIMET is a trademark of Novus International, Inc., and is registered in the United States and other countries.)

Key Words: Sulfur Amino Acids, Growth, Nursery Pigs

575 Effect of L-lysine-HCl level and true digestible lysine:crude protein ratio on late nursery pig performance. B. W. Ratliff^{*1}, A. M. Gaines¹, P. Srichana¹, R. W. Fent¹, G. L. Allee¹, J. L. Ustry², and R. D. Boyd³, ¹University of Missouri, Columbia, ²Ajinomoto Heartland LLC, Chicago, IL, ³The Hanor Company, Franklin, KY.

At a commercial research site, 792 pigs (TR-4 × C22; 13.0 kg) were used to evaluate the effect of L-lysineHCl level and true digestible (TID) lysine:crude protein (Lys:CP) ratio on nursery pig performance from 13 to 26 kg BW. Pigs were allotted to one of six dietary treatments with 6 replicate pens/treatment and 22 pigs/pen. Dietary treatments included five levels of L-lysineHCl that corresponded to concentrations of 0.30, 0.40, 0.50, 0.60, and 0.70% lysine, respectively. With increasing L-lysineHCl inclusion, the CP concentration decreased (21.8, 20.7, 19.6, 18.5 and 17.5%, respectively) and the TID Lys:CP ratio increased (5.96, 6.28, 6.62, 7.00 and 7.45%, respectively). To evaluate the effect of Lys:CP ratio, a 0.70% L-lysineHCl diet was formulated to contain 18.5% CP and a Lys:CP ratio of 7.00% using a 50:50 blend of L-glutamine and L-glycine. All diets were formulated at a 1.30% TID lysine and minimum ideal protein ratios were maintained (Thr, 65%; Met+Cys, 60%; Trp, 16.7%; Iso, 58%; and Val, 65%). Growth performance data were collected for 21 d. Results indicated a decrease (Linear, P < 0.01; Quadratic, P = 0.10) in ADG (631, 634, 639, 611 and 598 g, respectively) and reduced (Linear, P < 0.01; Quadratic, P = 0.06) G/F (0.684, 0.680, 0.679, 0.666 and 0.643, respectively) with increasing levels of L-lysineHCl inclusion. Feed intake was not affected (P > 0.73). Furthermore, for diets containing 0.70% L-lysineHCl, lowering the Lys:CP ratio to 7.00% increased (P < 0.03) ADG (630 vs. 598 g) and improved (P < 0.03) G:F (0.667 vs. 0.643). Two slope broken line analysis indicated a maximum L-lysineHCl inclusion of 0.50% for ADG and 0.55% for G:F. Collectively, these data indicate that up to 0.50% inclusion of L-lysineHCl has no negative effect on nursery pig performance and inclusion of 0.70% L-lysineHCl addition is possible when the Lys:CP is kept at or below 7.00%.

Key Words: Lysine, Crude Protein, Pigs

576 Estimation of the true ileal digestible sulfur amino acid:lysine ratio for growing pigs weighing 29 to 45 kilograms. A. M. Gaines^{*1}, G. F. Yi², B. W. Ratliff¹, P. Srichana¹, G. L. Allee¹, C. D. Knight², and K. R. Perryman², ¹University of Missouri, Columbia, ²Novus International, Inc., St. Louis, MO.

The objective of this research was to evaluate the optimum true ileal digestible (TID) sulfur amino acid:lysine (SAA:LYS) ratio for growing pigs weighing 29 to 45 kg reared under commercial conditions. A total of 2,208 growing pigs (TR4 × C22; 29.0 ± 0.1 kg) were allotted within sex (barrows and gilts) to one of six dietary treatments in a randomized complete block design with eight replicate pens (23 pigs/pen) per treatment/sex. Dietary treatments included five levels of TID SAA:LYS

ratios (49.5, 54.5, 59.5, 64.5, and 69.5%, respectively). Diets were formulated at a 0.90% TID lysine and contained 0.40% L-lysine-HCl. Dietary SAA content was increased by adding Alimet[®] feed supplement (88% L-methionine activity) with additional synthetic amino acids to meet the minimum amino acid profile. To evaluate the effect of 0.40% L-lysine-HCl supplemented low-protein amino acid fortified (LPAA) diets, a 0.15% L-lysine-HCl supplemented corn-soybean meal diet (high protein control) was also formulated (64.5% TID SAA:LYS ratio). Growth performance data were collected for 17 d. Increasing the TID SAA:LYS ratio increased (linear, $P < 0.001$; quadratic, $P < 0.01$) ADG (916, 951, 953, 958, and 956 g/d) and improved (linear, $P < 0.001$; quadratic, $P < 0.001$) gain:feed (0.459, 0.470, 0.477, 0.479, and 0.475). There were no differences in feed intake with increasing TID SAA:LYS ratios. However, feed intake was higher ($P < 0.01$) in pigs fed the LPAA diet compared to pigs fed the high protein control diet at 64.5% TID SAA:lysine ratio, which resulted in decreased ($P < 0.01$) gain:feed. Based on biological and economic data, the optimum TID SAA:LYS ratio that maximized return over feed cost was a 59.5%. This is in good agreement with estimates using the two slope broken line model, which indicated the optimum TID SAA:LYS ratio to be 59.7 and 61.1% for ADG and gain:feed, respectively. ([®]ALIMET is a trademark of Novus International, Inc., and is registered in the United States and other countries.)

Key Words: Sulfur Amino Acid, Growth, Growing Pigs

577 Estimation of the true ileal digestible sulfur amino acid:lysine ratio for early finishing gilts weighing 45 to 68 kilograms. A. M. Gaines^{*1}, G. F. Yi², B. W. Ratliff¹, P. Srichana¹, G. L. Allee¹, C. D. Knight², and K. R. Perryman², ¹University of Missouri, Columbia, ²Novus International, Inc., St. Louis, MO.

The objective of this research was to evaluate the optimum true ileal digestible (TID) sulfur amino acid:lysine (SAA:LYS) ratio for early finishing gilts weighing 45 to 68 kg reared under commercial conditions. A total of 827 finisher gilts (TR4 × C22; 44.7 ± 0.3 kg) were allotted to one of six dietary treatments in a randomized complete block design with six replicate pens (23 pigs/pen) per treatment. Dietary treatments included five levels of TID SAA:LYS ratios (50.2, 55.2, 60.2, 65.2, and 70.2%, respectively). Diets were formulated at a 0.85% TID lysine and contained 0.40% L-lysine-HCl. Dietary sulfur amino acid content was increased by adding Alimet[®] feed supplement (88% L-methionine activity) with additional synthetic amino acids supplied to meet the minimum amino acid profile. To evaluate the effect of 0.40% L-lysine-HCl supplemented low-protein amino acid fortified (LPAA) diets, a 0.15% L-lysine-HCl supplemented corn-soybean meal diet (high protein control) was also formulated (65.2% SAA:LYS ratio). Growth performance data were collected for 21 d. Increasing the TID SAA:LYS ratio increased (linear, $P < 0.09$; quadratic, $P < 0.09$) ADG (1,044, 1,056, 1,089, 1,084, and 1,069 g/d) and improved (quadratic, $P < 0.02$) gain:feed (0.416, 0.428, 0.429, 0.427, and 0.424). There were no differences in feed intake with increasing TID SAA:LYS ratios. However, feed intake tended to be higher ($P < 0.10$) in pigs fed the LPAA diet compared to pigs fed the high protein control diet, which resulted in lower ($P < 0.10$) gain:feed. Based on biological and economic data, the optimum TID SAA:LYS ratio that maximized return over feed cost was a 60.2%. This is in good agreement with estimates using the two slope broken line model, which indicated the optimum TID SAA:LYS ratio to be 62.0% for maximal ADG. ([®]ALIMET is a trademark of Novus International, Inc., and is registered in the United States and other countries.)

Key Words: Sulfur Amino Acids, Growth, Early Finishing Gilts

578 Evaluation of the true ileal digestible (TID) lysine requirement for 80-100 kg barrows and gilts. P. Srichana^{*1}, A. M. Gaines¹, B. W. Ratliff¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, Columbia, ²Ajinomoto Heartland LLC, Chicago, IL.

Two experiments were conducted at a commercial research site in order to evaluate the true ileal digestible (TID) lysine requirement for 80 to 100 kg barrows and gilts. In Exp.1, a total of 865 barrows (TR-4 × C22; 83.0 ± 0.3 kg) were used in a completely randomized design with 7 replicate pens/treatment. In Exp. 2, a total of 884 gilts (TR-4 × C22; 79.6 ± 0.4 kg) were used in a completely randomized design with 7 replicate pens/treatment. Pigs used in both experiments were allotted to one of six dietary treatments containing 0.50, 0.60, 0.70, 0.80, 0.90,

and 1.00% TID lysine. Diets used in the experiments were corn-soybean meal based diets and contained 0.15% L-lysine HCl. Dietary lysine content was increased by altering the corn:soybean meal ratio. Growth performance data were collected for 14 and 21 d, respectively, for Exp.1 and 2. For Exp. 1, increasing dietary lysine increased (quadratic, $P < 0.01$) ADG (907, 985, 983, 982, 961, and 957 g/d) and improved (linear, $P = 0.07$; quadratic, $P = 0.06$) G:F (0.294, 0.303, 0.314, 0.309, 0.310, and 0.308). For Exp. 2, increasing dietary lysine increased (linear, $P < 0.001$; quadratic, $P < 0.001$) ADG (898, 986, 1,000, 1,000, 969, and 1,004 g/d) and improved (linear, $P < 0.001$; quadratic, $P < 0.001$) G:F (0.317, 0.348, 0.346, 0.374, 0.354, and 0.358). Furthermore, increasing dietary lysine resulted in a linear decrease ($P = 0.05$) in ADFI (2,834, 2,830, 2,890, 2,807, 2,732, and 2,802 g/d). Using segmented regression procedures, the TID lysine requirement was estimated to be 0.61 and 0.68% for ADG and G/F, respectively, in barrows. The TID lysine requirement was estimated to be 0.61 and 0.77% for ADG and G/F, respectively, in gilts. These data indicate that from 80 to 100 kg BW, the optimum TID lysine requirement for barrows and gilts of this genotype is at least 0.60%.

Key Words: Lysine, Pigs, Growth

579 Effect of low-protein amino acid supplemented diets on performance and indicators of enteric health in early-weaned pigs. C. M. Nyachoti^{*1}, O. F. Omogbenigun¹, M. Rademacher², and G. Blank¹, ¹University of Manitoba, Winnipeg, MB, Canada, ²Degussa AG, Germany.

Previous research suggests that high dietary protein may encourage proliferation of intestinal pathogenic bacteria leading to post-weaning diarrhea in pigs. We used 96 pigs weaned at 18 d to study the effect of low-protein amino acid (AA) supplemented diets on performance, and intestinal microbial population and fermentation activities in a 3-wk trial. Four corn-wheat and soybean meal-based diets were assigned at random to six pens each with 4 pigs balanced for initial body weight and sex. The diets were a control containing 23% CP or the same diet but with CP reduced to 21%, 19% and 17% and supplemented with Lys, Thr, Trp, and Ile to equal that of the control. Diets were formulated to similar nutrient levels and provided for ad libitum intake. Blood was sampled on d 0, 7, 14, and 21 for determining plasma urea nitrogen (PUN). ADFI, ADG, and gain:feed (G:F) were determined weekly. On d 21, two pigs per pen selected at random, were sacrificed to determine intestinal histology, digesta pH, ammonia levels, volatile fatty acids (VFA), and luminal microbial counts. ADFI, ADG, and G:F were not affected ($P > 0.05$) by reducing CP by 2 percentage units but a reduction of 4 or more percentage units reduced ($P < 0.05$) ADFI and ADG over the 3-wk study period. Ileal digesta pH was lower ($P = 0.01$) in pigs fed low-protein diets compared with control. Ammonia nitrogen in ileal digesta, and PUN were reduced linearly ($P < 0.01$) as CP was reduced. With the exception of valeric acid, VFA levels in ileal digesta of piglets fed low-protein diets were generally lower ($P < 0.05$) compared with control. Diet had no effect on intestinal microbial counts ($P > 0.1$). The results show that when CP is reduced by four or more percentage units other AA may become limiting and support the hypothesis that low CP AA supplemented diets may help maintain enteric health in pigs by lowering microbial metabolites with toxic effects.

Key Words: Amino Acid Supplementation, Early-Weaned Pigs, Intestinal Health

580 The tryptophan requirement of growing and finishing barrows. J. L. Shelton^{*1}, A. C. Guzik¹, L. L. Southern¹, B. J. Kerr², and T. D. Bidner, ¹LSU Agricultural Center, Baton Rouge, LA, ²USDA-ARS-SOMMRU, National Swine Research and Information Center, Ames, IA.

Five experiments were conducted to determine the true digestible Trp (dTrp) requirement of growing and finishing barrows. Treatments were replicated with three or four replications of three or four barrows per pen. Broken line regression was used to estimate the dTrp requirement in all experiments. Experiment 1 was conducted with 27 barrows (initial and final BW of 78.3 and 109.8 kg, respectively) to validate whether a corn-feather meal (C-FM) Trp-deficient diet, with added crystalline L-Trp, would result in growth performance and carcass traits similar to a corn-soybean meal (C-SBM) diet. Barrows fed the C-FM diet without L-Trp addition had decreased growth performance and carcass traits, and an increased plasma urea N (PUN) concentration ($P < 0.01$). Adding

L-Trp to the C-FM diet resulted in similar growth performance and carcass traits as barrows fed the C-SBM diet ($P > 0.10$). In Exp. 2, 60 barrows (initial and final BW of 74.6 and 104.5 kg, respectively) were used to estimate the dTrp requirement. The levels of dTrp used in Exp. 2 were 0.06, 0.08, 0.10, 0.12, or 0.14%. Response variables were growth performance, PUN concentrations, carcass traits, and pork quality. The dTrp requirement was estimated to be 0.102%. In Exp. 3, 4, and 5, barrows ($n = 60, 60, \text{ or } 80$, respectively) were allotted to five dietary treatments supplemented with crystalline L-Trp, and PUN concentration was the response variable. The levels of dTrp in Exp. 3 (BW was 30.9 kg) were 0.13, 0.15, 0.17, 0.19, or 0.21%. The dTrp requirement was estimated to be 0.167%. The levels of dTrp in Exp 4 (BW was 51.3 kg) were 0.09, 0.11, 0.13, 0.15, or 0.17%. The dTrp requirement was estimated to be 0.134%. The levels of dTrp in Exp. 5 (BW was 69.4 kg) were 0.07, 0.09, 0.11, 0.13, or 0.15%. The dTrp requirement was estimated to be 0.096%. These data indicate that the dTrp requirements of barrows weighing 30.9, 51.3, 69.4, and 74.6 to 104.5 are 0.167, 0.134, 0.096, and 0.102%, respectively.

Key Words: Barrows, Requirement, Tryptophan

581 The isoleucine requirement of 80- to 120-kilogram barrows. D. W. Dean^{*1}, L. L. Southern¹, B. J. Kerr², and T. D. Bidner¹, ¹LSU Agricultural Center, Baton Rouge, LA, ²USDA-ARS-MWA-SOMMRU, Ames, IA.

Three experiments were conducted to validate an Ile deficient diet and then to determine the Ile requirement of 80- to 120-kg barrows. Cross-bred barrows ($n = 60, 80, \text{ or } 80$ with initial BW of 93, 82, and 85 kg, respectively) were used in each experiment. In Exp. 1, five replications with four pigs per pen were fed diets containing either a corn-soybean meal diet (C-SBM) or a corn-based diet containing 5% blood cells (BC) with or without 0.26% supplemental Ile (C-BC+Ile or C-BC) in a 28-d growth assay. On d 14, pigs receiving the C-BC diet were taken off experiment due to a severe depression in feed intake. Growth performance was not different for pigs fed C-SBM or C-BC+Ile ($P = 0.36$) over the 28-d experiment. In Exp. 2, four replications with four pigs per pen were fed the C-BC diet containing 0.24, 0.26, 0.28, 0.30, or 0.32% true digestible (TD) Ile. The experiment lasted 7 d and was an attempt to estimate the Ile requirement using plasma urea nitrogen (PUN) as the response variable. Because of dramatic incremental increases in ADFI as TD Ile was increased, PUN could not be used to estimate the Ile requirement. In Exp. 3, five replications with four pigs per pen were fed the C-BC diet containing 0.28, 0.30, 0.32, 0.34, or 0.36% TD Ile. Three pigs per pen were slaughtered on d 33 or 61 for determination of carcass lean and fat measurements (117.8 kg average final BW). Daily gain, ADFI, and gain:feed were increased linearly ($P = 0.007$) as Ile was increased in the diet. There were no effects of TD Ile level on 10th rib fat depth or loin muscle area; however, kilograms of lean was increased linearly ($P < .001$) as TD Ile level increased. In summary, the Ile deficiency of a C-BC diet can be corrected by the addition of supplemental Ile, and the PUN method is not suitable when assessing Ile requirement due to dramatic changes in ADFI. The TD Ile requirement for 80- to 120-kg barrows for maximizing feed intake, growth, and kilograms of lean is not less than 0.36%.

Key Words: Isoleucine, Pig, Plasma Urea Nitrogen

582 Determination of the optimum threonine:lysine ratio for prolific lactating sows. A. M. Gaines^{*1}, N. H. Williams², M. E. Johnston³, C. Zier², G. L. Allee¹, J. L. Usry⁴, and R. D. Boyd³, ¹University of Missouri, Columbia, ²Pig Improvement Company, Franklin, KY, ³The Hanor Company, Inc., Franklin, KY, ⁴Ajinomoto Heartland LLC, Chicago, IL.

This study was conducted to determine the optimum threonine:lysine ratio for prolific lactating sows. A total of 269 PIC product sows (parities

1-6) were allocated by parity to four dietary threonine concentrations, 0.51, 0.58, 0.64, and 0.70%. Diets were formulated to contain 0.90% total lysine which, based on expected litter growth rate (2.35 kg/d), would have been below requirement. The four concentrations of threonine corresponded to total threonine:lysine ratios of 0.57, 0.64, 0.71, and 0.78, respectively. Experimental diets were corn-soybean meal based diets and contained 0.29% L-lysine-HCl. Soybean meal was held constant and dietary threonine was increased by adding L-threonine with additional synthetic amino acids supplied as necessary to meet the minimum amino acid profile. Sows were fed ad libitum from d 112 of gestation through a 19 d lactation period. Litter size was standardized by 24 h post-farrowing (avg. 11.5 pigs/litter). There was no treatment difference ($P > 0.41$) in sow feed intake (avg. 6.3 kg/d). Sow weight loss during lactation ranged from 11.4-17.5 kg and was not affected by threonine:lysine ratio ($P > 0.15$). Increasing the threonine:lysine ratio improved litter weight gain (quadratic, $P < 0.06$), litter weaning weight ($P < 0.05$), and the number of pigs weaned (quadratic, $P < 0.06$). The highest threonine:lysine ratio (0.78) was detrimental to both piglet livability (88.6 vs. 91.2%) and litter growth rate (2.10 vs. 2.34 kg/d). A threonine:lysine ratio of 0.64 appears to optimize milk production and pigs weaned for high producing lactating sows nursing large litters. This estimate was the same for both younger (parity 1-2) and older sows (parity 3-6).

Key Words: Threonine, Lactation, Sows

583 The valine requirement of lactating sows. M. Etienne^{*1}, J. Y. Dourmad¹, J. Noblet¹, L. Le Bellego², and C. Relandeau², ¹INRA-UMRVP, Saint-Gilles, France, ²Ajinomoto Eurolysine sas, Paris, France.

This study was undertaken to determine the effects of the valine:lysine ratio in the lactation diet on sow and piglet performance, milk and piglet compositions, and nitrogen balance of sows. A basal diet with barley, wheat, peas and soybean meal containing 135 g/kg CP was fortified with crystalline amino acids to reach an optimal balance between essential amino acids except for valine. The lysine level was limiting (7.6 g/kg), and crystalline L-valine was added so that the valine:lysine ratio was below (0.70, diet L), met (0.89, diet M) or exceeded (1.28, diet H) estimated requirements (INRA, 1991). Twelve replicates of three Landrace x Large White sows (mean parity, 2.5) were fed the experimental diets during a 25-d lactation. Litters were equalized to 13.7 piglets after farrowing. They did not have access to creep feed. Sow feed intake increased progressively up to 6 kg/d within 5 d and then remained constant. Feces and urine of sows were collected from 5 to 25 d of lactation. Body composition of two piglets/litter sacrificed at weaning was determined. Weight and backfat depth losses during lactation (26.7 kg and 2.8 mm, respectively) did not differ between groups. The mean number of piglets nursed (12.6) or weaned (12.1) was not affected by treatments. Mean piglet (6.47 kg) and litter weight at weaning (78.3 kg) and average daily gain of piglets (194 g/d) and litters (2.29 kg/d) were similar in the three groups. No significant effect of diet was found on milk composition determined at 5, 15 and 25 d of lactation. Mean dry matter, nitrogen, and energy output in milk estimated through growth rate and composition of body weight gain of the piglets were also unaffected (1.53 kg, 63.6 g, and 41.9 MJ/d, respectively). Piglets in the L group had more dry matter and fat and less nitrogen ($P < 0.05$) in their body than those in groups M and H. The N retention coefficient in sows did not differ between groups. It is concluded that there is no advantage to increase the valine:lysine ratio in the lactation diet of sows beyond 0.90.

Key Words: Sows, Valine, Lactation

Physiology and Endocrinology: Nutritional Regulation of Reproduction

584 Energy balance, dry matter intake, and hormone profiles of cows with ovulatory and non-ovulatory follicles during the first postpartum follicle wave. S. T. Butler^{*} and W. R. Butler^{*}, Cornell University, Ithaca, NY.

An early resumption of ovulatory activity following parturition is positively associated with subsequent measures of reproductive success.

Postpartum energy balance (EB) affects ovarian follicle development and likelihood of ovulation. This study was carried out to assess whether differences in transition period EB (pre- and postpartum) also contribute to differences in postpartum follicular activity (study period = d -21 to d 30 relative to parturition). First wave follicle development was fol-

lowed via ultrasound in fifty-five mature Holstein cows, and the follicle waves were retrospectively categorized as being ovulatory (O; n=17), non-ovulatory high E2 (NH; n=6), non-ovulatory low E2 (NL; n=24), or cystic (n=8). The cystic cows were excluded, and the remaining data were analyzed by ANOVA and repeated measures ANOVA. Peak plasma estradiol (E2) concentrations were similar in O and NH cows (5.8 ± 0.7 vs. 6.0 ± 1.1 pg/ml; $P=0.8$), and were higher in both groups ($P<0.001$) than NL cows (1.2 ± 0.5 pg/ml). Energy balance in the NL cows during the pre- and postpartum periods (10.8 ± 0.4 and -12.2 ± 0.6 Mcal/d) were less favorable than in either the O (13.6 ± 0.5 and -8.3 ± 0.8 Mcal/d; both $P<0.001$) or NH cows (15.8 ± 0.8 and -9.0 ± 1.2 Mcal/d; $P<0.001$ and $P<0.05$). Divergence between groups in EB started as early as d -21 and continued through d 30. There were no differences between groups in milk yield ($P>0.2$), and differences in EB were paralleled by differences in DMI. In accordance with the EB results, NL cows had lower insulin and glucose and higher NEFA than O cows (all $P<0.001$) and NH cows ($P<0.05$, $P=0.16$ and $P<0.06$, respectively). The NL cows had a more severe negative EB nadir compared with O ($P<0.08$) and NH cows ($P<0.05$). In conclusion, EB was least favorable in NL cows. This status commenced up to 3 weeks prior to parturition and carried over through the postpartum follicular wave. Conversely, NH cows had a similar EB profile to O cows and produced similar levels of E2, but failed to ovulate.

Key Words: Energy Balance, Ovulation, Estradiol

585 Effects of feeding menhaden fish meal or Ca salts of fish oil fatty acids on uterine fatty acids composition, COX-2 level and PGF_{2α} production in early lactating cows. A. Heravi Moussavi¹, R. O. Gilbert², T. R. Overton², D. E. Bauman², and W. R. Butler², ¹Dept. of Animal Science, Ferdowsi University, Mashhad, Iran, ²Cornell University, Ithaca, NY.

The study was designed to test the effects of dietary fatty acid supplementation on uterine fatty acid composition, cyclooxygenase-2 (COX-2) level, and PGF_{2α} production in early lactating cows. From d 5-50 postpartum, cows (n = 30; 6/treatment) were fed diets that were isonitrogenous, isoenergetic and isolipid containing 0 (Control), 1.25, 2.5 or 5 % menhaden fish meal (FM) or 2.3% Ca salts of fish oil fatty acids (CaFOFA). At day 23 postpartum, cows were induced to a synchronized ovulatory cycle with an i.m. injection of 100 μg of GnRH followed after 7 days by i.m. administration of 30 mg of PGF_{2α} and a second injection of GnRH 48 h later. On d 15 after second GnRH injection, cows were injected with 100 IU oxytocin (i.v.) at 11.00 h. Blood samples were collected at 15-min intervals from 1 h before to 3 h after the oxytocin injection and at 30-min intervals from 3 to 4 h after oxytocin injection to monitor uterine secretion of PGF_{2α} measured as 13,14-dihydro 15-keto PGF_{2α} (PGFM). After completion of blood sampling, uterine endometrium biopsy samples were taken for fatty acid analysis and Western blot for COX-2 concentration. The uterine fatty acid composition of eicosapentaenoic acid (EPA, C20:5, n-3) and docosahexaenoic acid (DHA, C22:6, n-3) were significantly ($P<0.0001$) increased by supplementation with fish meal and CaFOFA to as much as 3-fold. Arachidonic acid (AA, C20:4, n-6) was decreased by adding 5 % FM ($P<0.05$). The uterine level of COX-2 protein and PGFM area under curve after administration of oxytocin were not significantly different among diets. Results from this experiment demonstrate that dietary fatty acid supplementation significantly increases uterine omega-3 fatty acid concentration with no apparent effect on COX-2 level and PGF_{2α} production after oxytocin challenge in early lactation dairy cows.

Key Words: Fish meal, COX-2, PGF_{2α}

586 Effect of fat sources differing in fatty acid profile on fertilization rate and embryo quality in lactating dairy cows. R. L. A. Cerri¹, R. G. S. Bruno¹, R. C. Chebel¹, K. N. Galvao¹, H. Rutigliano¹, S. O. Juchem¹, W. W. Thatcher², D. Luchini³, and J. E. P. Santos¹, ¹University of California, Davis, ²University of Florida, Gainesville, ³Bioproducts, Inc..

Holstein cows, 154, were randomly assigned to one of two treatments consisting of either a Ca salt of linoleic and trans fatty acids (LTFA) or of palm oil (PO). Cows consumed 250 and 350 g/d of the supplemental fats during the last 25 d of gestation and first 60 d in milk (DIM), respectively. Cows were pre-synchronized with a CIDR and GnRH at 30 DIM, followed 7 d later by PGF_{2α} and CIDR removal. The Ovsynch protocol was initiated 2 d after CIDR removal and all cows were timed AI by the

same person 12 h after the last GnRH. Blood samples were collected at all injections in the Ovsynch and then at d 1, 3 and 5 d after AI for P4 analysis. Ovaries were examined by ultrasound throughout the synchronization protocol, and cows were flushed at 5.5 d after timed AI. Structures were evaluated visually and using vital staining with propidium iodine followed by Hoescht. Continuous, binomial, and count data were analyzed using the GLM, GENMOD, and LOGISTIC procedures of SAS (2001), respectively. Ovulation to the first and second GnRH and double ovulation to the second GnRH of the Ovsynch were similar ($P>0.25$) across treatments and averaged, respectively, 83.7, 86.4, 19.1%. Diameter of the ovulatory follicle at the second GnRH of the Ovsynch and of the CL at embryo collection were similar ($P>0.80$) across treatments and averaged, respectively, 18.6 and 22.2 mm. A total of 86 structures were recovered (41 LTFA and 45 PO), and recovery rate (structure/CL) was similar for LTFA and PO (51.9 vs 54.9%; $P>0.15$). Fertilization rate (87.2 vs 73.3%; $P=0.11$), number of total cells (19.4 vs 14; $P=0.13$), and percentage of live cells (94.2 vs 85.3%; $P=0.09$) all tended to be higher for LTFA than PO. Similarly, the percentage of high quality embryos (grades 1 and 2) were higher for LTFA compared with PO (73.5 vs 51.5%; $P=0.06$), and number of accessory sperm cells attached to the zona pelucida/structure were higher (34.3 vs 21.5; $P<0.001$) for LTFA than PO. These results suggest that feeding Ca salts of LTFA improve fertilization rate and embryo quality in lactating dairy cows. Supported by NRI/USDA Grant 2003-02742.

Key Words: Embryo, Fatty Acids, Dairy Cows

587 Expression of growth hormone receptor and IGF-I mRNA in the reproductive tissues of early postpartum dairy cows. M. L. Rhoads*, J. P. Meyer, S. J. Kolath, W. R. Lamberson, and M. C. Lucy, University of Missouri, Columbia.

The growth hormone (GH)/IGF-I system plays a critical metabolic role in dairy cattle. In liver, GH receptor (GHR) and IGF-I are dynamically regulated by lactation and energy balance. Less is known about the regulation of GHR and IGF-I mRNA in reproductive tissues. The objective of this study was to measure total GHR (tGHR) and IGF-I mRNA expression in the liver, uterus, corpus luteum (CL) and follicle in Holstein cows (n=21) sampled three times during early lactation. GnRH was administered within 15 d postpartum to induce first ovulation. Nine d after ovulation (23 ± 1 d postpartum) the liver, uterus, CL and first wave dominant follicle (DF; follicular fluid aspiration for granulosa cell collection) were sampled. PGF_{2α} and GnRH were injected 7 and 9 d after sample collection to synchronize the second (41 ± 1 d postpartum) and third (60 ± 1 d postpartum) tissue collections. Total RNA was isolated and used for mRNA analysis by real-time quantitative PCR. Uterus, CL and DF expressed less tGHR (0.1 ± 0.8 , 8.3 ± 0.9 and 1.4 ± 0.9 AU, respectively; $P<0.01$) and IGF-I (4.3 ± 2.7 , 12.0 ± 2.9 and 6.4 ± 3.1 AU, respectively; $P<0.01$) than liver (24.4 ± 0.8 and 47.2 ± 2.7 AU, respectively). GHR1A mRNA in liver and tGHR and IGF-I mRNA in liver and reproductive tissues were unaffected by stage of lactation ($P>0.10$). The tGHR mRNA was correlated with IGF-I mRNA in liver ($r=0.42$; $P<0.01$), uterus ($r=0.78$; $P<0.01$) and CL ($r=0.40$; $P<0.01$), but not DF. Liver IGF-I mRNA ($r=0.33$; $P<0.01$) and plasma IGF-I concentrations ($r=0.31$; $P<0.02$) were correlated with body condition score (BCS) from calving to sample collection. The effects of BCS loss on reproductive tissues were opposite to that observed in liver. The tGHR mRNA in CL ($r=0.37$; $P<0.01$) and the IGF-I mRNA in DF ($r=0.31$; $P<0.05$) increased with greater BCS loss. The metabolic control of tGHR and IGF-I differed between liver and reproductive tissues. Reproductive tissues may compensate for low BCS with localized synthesis of tGHR and IGF-I.

Key Words: Growth Hormone Receptor, IGF-I, Reproduction

588 Influence of postpartum nutrition of primiparous beef cows on insulin-like growth factor binding proteins in follicular fluid and plasma. I. Rubio*, F. J. White, N. H. Ciccioli, R. P. Wettemann, and L. J. Spicer, Oklahoma Agricultural Experiment Station, Oklahoma State University, Stillwater.

Effect of postpartum nutrient intake on insulin-like growth factor binding proteins (IGFBPs) in dominant follicles (DF) and plasma was evaluated at 56 ± 9 d postpartum in anovulatory primiparous Angus x Hereford cows. Body condition score (BCS) at calving was 4.8 ± 0.2 . Cows (n=28) were blocked based on BCS and randomly assigned to one of two nutritional treatments at calving; moderate (M), 2.3 kg/d of a 40

% CP supplement and ad libitum hay, or high (H), ad libitum access to a 12% CP-50 % concentrate diet and hay. Blood samples were collected twice a week starting at 30 d postpartum. Ovarian follicles were evaluated daily by ultrasonography commencing at 42 d postpartum. When growth of DF plateaued, follicular fluid (FF) was obtained by transvaginal ultrasound-guided follicular aspiration. Data were analyzed using the MIXED procedure of SAS and Pearson correlation coefficients. Concentrations of IGF-I in FF were greater ($P < 0.01$) for H (34.0 ± 10.7 ng/ml) than M (23.6 ± 8.5 ng/ml) cows, but concentrations of progesterone, androstenedione, and estradiol in FF were not influenced ($P > 0.10$) by treatment. Concentrations of IGFBP-4 and -5 in plasma were 30% greater ($P < 0.01$) in H than in L cows. Concentrations of IGFBP-4 and -5 in FF were 68 and 48%, respectively, greater ($P < 0.05$) for H than M cows. Concentrations of IGFBP-2 and -3 in plasma and FF were not influenced by treatment. Concentration of IGFBP-2 and -5 in plasma at follicular aspiration were positively correlated with follicle size ($P < 0.05$) and IGFBP-2 in FF was correlated with follicle size. BCS at calving was positively correlated with IGFBP-2, -4 and -5 in plasma at aspiration of follicles. Concentration of IGF-I in plasma at aspiration and in FF were positively correlated with IGFBP-3 and -4 in FF. Although concentrations of IGFbps in FF were not correlated with IGFbps in plasma, similar increases in both systemic and intrafollicular IGFBP-4 and -5 in cows with greater nutrient intake, indicate that these two IGFbps may be regulated by the same nutritionally driven endocrine or metabolic changes.

Key Words: Insulin-like Growth Factor Binding Proteins, Nutrition Postpartum, Cow

589 Reproductive performance of primiparous and multiparous cows fed whole soybeans before breeding. N. M. Long^{*2}, G. M. Hill¹, J. F. Baker¹, W. M. Graves², M. A. Froetschel², B. G. Mullinix, Jr.¹, and D. H. Keisler³, ¹University of Georgia, Tifton, ²University of Georgia, Athens, ³University of Missouri, Columbus.

Effects of supplemental energy before breeding on primiparous (PC; 508.84 ± 35.8 kg BW) and multiparous (MC 581.4 ± 66.57 kg BW) reproductive performance were determined using Angus (A; PC=17; MC=36) and Polled Hereford (PH; PC=12, MC=11) beef cows. Parity (P), breed, cow and calf initial BW, and calf age were used to rank cows before random assignment to control (C; no supplementation, PC = 15, MC= 25) or soybean (S; cracked whole soybeans 2.26 kg/cow daily, PC=14; MC=24) treatments (T) during a pre-breeding period (Feb 11 to Apr 11). The breeding interval began April 14, estrual activity was monitored visually and by Heatwatch[®] system, and cows were bred A.I.(d 1 to d 44), or natural service (fertile bulls, d 45 to d 71). Cow blood serum (Feb 11 and Apr 11) was analyzed for triglyceride, cholesterol, low and high density lipids, and leptin (TRIG, CHO, LDL, HDL, LEP, mg/dl). Calf ADG (kg) from Feb 11 to end of breeding season, with birthweight as a covariate was affected ($P < 0.10$) by P (PC and MC within C and S, respectively, were : 0.91, 0.95, 0.93, 0.98, SE = 0.023). Pregnancy rate (%) on Sep 17, for PC and MC within C and S, respectively, were: 66.7, 85.0, 62.5, 58.3, SE = 8.2, and it was unaffected by T and P. Initial values for CHO, LDL, HDL and TRIG were unaffected ($P > 0.10$) by T or P, but all increased by Apr 11, resulting in differences (adjusted using Feb 11 data) shown in the table. Leptin values increased from Feb 11 to Apr 11 for all treatments except PC-C. Feeding S to PC cows resulted in increased LEP ($P = 0.05$), and elevated TRIG, CHO, LDL, and HDL of PC-S to levels comparable with MC.

Item	Control (C)		Soybeans (S)		SE	T	P	TxP
	PC	MC	PC	MC				
TRIG (APR 11)	28.1	25.9	32.6	29.7	1.55	**		
CHO (APR 11)	133.7	180.7	190.9	202.8	8.10		*	
HDL (APR 11)	104.6	143.1	145.5	160.1	6.20		*	
LDL (APR 11)	23.4	32.2	39.2	36.6	2.06			**
LEP					SE between dates =			
(Feb 11) ^k LEP	6.8a	5.5b	6.7bm	4.1bn	0.58 (a,b)			
(APR 11) ^k	5.7any	9.0am	8.4ax	8.6a	SE between T = 0.81 (n, m or x,y) [P = 0.05]			

^kLEP had T x P x Date ($P < 0.01$); T an P tested by Satterthwaite option, Proc Mixed, SAS.

Key Words: Cow, Soybean, Leptin

590 Recombinant oleptin does not acutely accelerate the frequency of LH pulses at any developmental stage in normal and growth-restricted heifers. D. A. Zieba^{1,2}, M. Amstalden^{1,2}, S. Morton^{1,2}, D. H. Keisler³, and G. L. Williams^{*1,2}, ¹Animal Reproduction Laboratory, Texas A&M University Agricultural Research Station, Beeville, TX, ²Department of Animal Science and Center for Animal Biotechnology and Genomics, College Station, TX, ³Department of Animal Science, University of Missouri, Columbia.

Leptin plays critical roles in communicating nutritional status to the central reproductive axis in mammals and is necessary for sexual maturation. However, there is an emerging consensus that leptin may serve merely as a permissive signal for puberty. This is supported by the fact that chronic treatment of well-fed heifers with recombinant ovine leptin (oleptin) fails to accelerate the timing of puberty. Nonetheless, oleptin acutely stimulates gonadotropin secretion during nutritional stress in cows, and prevents fasting mediated reductions in frequency of LH pulses in peripubertal heifers. Therefore, objectives herein were to determine whether leptin could act to accelerate acutely the frequency of LH, and putatively GnRH, pulses at some critical point(s) of development in heifers fed normal or growth-restricted diets Ten-month old prepubertal heifers were assigned randomly to one of two dietary groups: 1) Normal Growth (a BW gain of 0.68 kg/d; and 2) Restricted Growth (a BW gain of 0.3 kg/d). Every 5 wk, each heifer received in random order on each day of a 2-d experiment, three hourly injections of either saline or oleptin (0.2 µg/kg BW i.v.). Blood samples were collected every 10-min for 5 h during each experimental period. The experiment ended when all normal-growth heifers had reached puberty. None of the restricted-growth heifers reached puberty during the study. Mean circulating concentrations of leptin were approximately 70% lower ($P < 0.001$) in restricted- compared to normal-growth heifers. Mean plasma LH and amplitude of LH pulses in restricted-growth heifers were less ($P < 0.01$) than in normal-growth heifers. Leptin treatment acutely increased ($P < 0.002$) mean circulating leptin 1.7- to 2.0-fold and slightly but significantly ($P < 0.02$) increased mean concentrations of LH over all periods, regardless of diet. Neither frequency nor individual characteristics of LH pulses were altered acutely by leptin treatment at any age. We conclude that changes in sensitivity of the hypothalamic-hypophyseal axis to leptin do not occur as a function of sexual maturation (USDA-NRI 00-35203-9132).

Key Words: Heifer, Leptin, LH

591 Effect of prenatal nutrition on plasma glucose at birth and weaning. D. W. Kastner^{*}, I. Rubio, F. J. White, N. H. Ciccioli, and R. P. Wettemann, Oklahoma Agricultural Experiment Station, Stillwater, OK.

Two experiments (Expt) were conducted to determine the effect of high (H) or low (L) energy and protein diets of cows during gestation on

plasma concentrations of glucose in calves at birth and after weaning. In Expt 1, mature Angus x Hereford cows received a 12% CP - 50% concentrate diet ad libitum (H, n=12), or grazed dry prairie grass and received 0.45 kg/d of a 40% CP supplement (L, n=10) from approximately 118 to 202 d of gestation. Calves were born between February 12 and April 3. H cows gained 143 ± 6 kg and 2.1 ± 0.2 body condition scores (BCS; 1=emaciated, 9=obese) and L cows gained 31 ± 7 kg and 0.2 ± 0.2 BCS. In Expt. 2, H cows (n=10) received a 50% concentrate diet ad libitum and L cows (n=9) received 4 kg/d of prairie hay and 0.45 kg/d of a 20% CP supplement from approximately 78 to 174 d of gestation. H cows gained 138 ± 4 kg and 1.7 ± 0.2 BCS and L cows gained 7 ± 4 kg and lost 0.3 ± 0.1 BCS. Cows calved between March 13 and April 29. Birth weights of calves were not influenced by diet that cows received during mid-gestation. Weaning weights were greater for calves from H than L cows in Expt 1 ($P < 0.06$) and 2 ($P < 0.01$). At 30 d of treatment (Expt 2), H cows had greater ($P < 0.05$) concentrations of glucose, thyroxine and NEFA in plasma than L cows. Concentrations of glucose in plasma of calves at birth were not influenced by treatment in either experiment. At weaning (Expt 1), concentrations of glucose were greater ($P < 0.05$) in H than L cows but NEFA and IGF-I levels were not influenced by treatment. H and L calves (Expt 2) responded differently to a glucose tolerance test after weaning. Concentrations of glucose with time after infusion were greater ($P < 0.01$) at 3 wk after weaning for H than L calves and tended to be greater ($P < 0.10$) for H than for L calves at 3.5 mo after weaning. We conclude that exposure of cows to high energy diets that cause increased glucose in plasma during mid-gestation, may influence regulation of concentrations of glucose in plasma of calves after weaning.

Key Words: Calf, Glucose, Prenatal

592 The role of food intake on estrous cyclicity and reproductive potential in white-tailed deer (*Odocoileus virginianus*). E. L. Monaco^{*1}, R. L. Stanko¹, and D. G. Hewitt², ¹Department of Animal and Wildlife Sciences, Texas A&M University, Kingsville, ²Caesar Kleberg wildlife Research Institute, Texas A&M University, Kingsville.

Nutritional status at the time of breeding can influence reproduction of cervids, but specific effects on timing of reproduction are not fully understood. We studied the effects of a non-restricted diet versus a restricted diet on deer reproduction. Baseline data were collected in Year 1 when penned does (n=16) were feed a high quality pellet (18% CP, 36% CF, Moormans[®] 6193) and alfalfa hay ad libitum. In Year 2, does were allocated randomly to feed restriction treatments which occurred from September (week 1) through early December (Early, E; n=8) or mid-January (Late, L; n=8). A ration of a 50:50 mix of high quality:low quality pellet (16% CP, 55% CF, Purina[®] 34A7) and sudan hay was fed. Amount fed per day was calculated as 80% of average DMI from companions of similar size (n=8). Blood was taken via jugular venipuncture on weeks 1, 4, 7 through 26, and 30 and body weights (BW) were recorded. Serum was analyzed for progesterone, triiodothyronine (T₃), and thyroxine (T₄). Estrous cyclicity and reproductive outcome was recorded for both years. Feed restriction decreased ($P < .01$) BW, T₃, and T₄. Serum T₄ was lower ($P < .05$) in L than E does. However, BW and T₃ were similar ($P > .1$) between treatments. Between years, feed restriction delayed ($P < .01$) onset of estrous cyclicity and increased ($P < .01$) the number of estrous cycles before conception. Week of first estrous cycle and week of conception were delayed ($P < .01$) in L does. Data suggest that white-tailed does consuming a low quality diet prior to the breeding season can successfully reproduce if high quality food becomes available.

Key Words: Deer, Nutrition, Reproduction

593 Performance and semen quality of yearling bulls grazing tall fescue pastures. G. M. Schuenemann^{*1}, J. C. Waller¹, F. M. Hopkins², H. S. Adair², N. R. Rohrbach¹, F. N. Scenna¹, D. I. Bryant¹, A. M. Saxton¹, J. W. Oliver³, J. C. Riggins⁴, and F. N. Schrick¹, ¹Department of Animal Science, University of Tennessee, Knoxville, ²Department of Large Animal Clinical Sciences, University of Tennessee, Knoxville, ³Department of Comparative Medicine, University of Tennessee, Memphis, ⁴Highland Rim Experiment Station, University of Tennessee, Springfield.

During a two-year study, performance and semen quality of yearling beef bulls grazing Kentucky 31 tall fescue (*Festuca arundinacea* Schreb.) infected with *Neotyphodium coenophialum*, an ergot alkaloid-producing fungal endophyte (E+; n = 20/yr); E+ plus ladino (*Trifolium repens*) and red (*T. pratense*) clovers (E+Cl; n = 10/yr); or Jesup tall fescue with the non-ergot alkaloid-producing endophyte strain MaxQ#8482 (MaxQ; n = 10/yr) were determined. Bulls were grouped by scrotal circumference (SC; 28 ± 1.6 cm); BW (303 ± 13.5 kg), breed composites, and age (296 ± 20.2 d) to graze E+, E+Cl, or MaxQ tall fescue pastures from November to July (224 d). Blood samples, ADG, SC and rectal temperatures (RT) were collected every 14 d. Scrotal temperatures (ST) were obtained by thermography before semen collection in May and June. Semen samples were immediately evaluated for motility and normal morphology. A mixed model procedure that included treatment, time, year, pasture (treatment), and all interactions as fixed effects was used to compare differences among treatment. Bulls grazing E+ and E+Cl pastures had increased RT (39.1 ± 0.04 and 39.0 ± 0.04 vs $38.7 \pm 0.06^\circ\text{C}$; $P < 0.0001$) and decreased prolactin (28.5 ± 4.3 and 39.5 ± 6.2 vs 102.5 ± 6.2 ng/mL; $P < 0.0001$) compared to bulls grazing MaxQ pastures. However, bulls grazing E+ had lower ST (32.7 ± 0.2 vs 33.1 ± 0.2 and $33.5 \pm 0.2^\circ\text{C}$; $P = 0.05$) and decreased ADG (0.6 ± 0.02 vs 0.85 ± 0.03 and 0.8 ± 0.03 kg/d; $P < 0.0001$) compared to bulls grazing E+Cl and MaxQ pastures. Testosterone, SC, and semen motility and morphology did not differ between treatments. In conclusion, motility and gross morphology of semen were not altered in bulls grazing E+ tall fescue pastures. Addition of clover to E+ pastures reduces the adverse effects on growth performance and scrotal temperature associated with fescue toxicosis.

Key Words: Tall Fescue, Bull, Fertility

594 Effects of P.G. 600 treatment at weaning on reproductive performance of sows limit-fed during lactation. B. R. Horsley^{*}, M. J. Estienne, A. F. Harper, and J. W. Knight, Virginia Polytechnic Institute and State University, Blacksburg.

The objective was to determine whether treatment with 400 I.U. PMSG and 200 I.U. hCG (P.G. 600; Intervet America, Inc.; Millsboro, DE) at weaning would improve reproductive performance of sows limit-fed during lactation. First- and second-parity, crossbred sows (213.3 ± 2.4 kg BW and 17.2 ± 0.5 mm last-rib backfat thickness) nursing 10.0 ± 0.3 pigs each were allowed ad libitum access to feed (AL; n = 18) or were limited to 3.2 kg of feed/d (L; n = 35) during an 18-d lactation. AL sows consumed more feed ($P < 0.01$) than did L sows (5.3 vs. 3.1 kg/d; SE = 0.05). L sows lost more ($P < 0.01$) BW (22.2 vs. 2.6 kg; SE = 2.4) and backfat (3.1 vs. 0.6 mm; SE = 0.6) compared to AL sows. There was no effect ($P = 0.99$) of feeding level on pigs weaned ($88.7 \pm 3.0\%$), but pig BW at weaning was greater ($P < 0.01$) for AL sows compared to L sows (6.3 vs. 5.6 kg; SE = 0.2). At weaning, L sows received i.m. treatment with P.G. 600 (L + P.G. 600; n = 16) or saline (L + saline; n = 19) and AL sows received saline (AL + saline; n = 18). Sows in estrus by d 7 post-weaning was greater ($P < 0.05$) for AL + saline sows (94.4%) compared to L + saline sows (68.4%), with L + P.G. 600 sows having an intermediate value (87.5%) that was not different ($P > 0.05$) from the other two groups. The weaning to estrus interval (5.2 ± 0.1 d) and sows pregnant at d 30 post-mating (84.1%) were not different among groups ($P > 0.1$). Following slaughter at d 30 of gestation, the number of corpora lutea (17.8 ± 0.6), number of live embryos (10.6 ± 0.6), embryonic survival ($61.1 \pm 3.5\%$), and embryo weight (1.56 ± 0.07 g) and crown-rump length (27.3 ± 0.4 mm) were not different ($P > 0.1$) among groups. In summary, low feed intake during lactation decreased the percentage of sows that displayed estrus within 7 d after weaning, an effect partially remediated by gonadotropin treatment. Pregnancy rate and litter size at day 30 of gestation were similar for AL and L sows and not affected by P.G. 600 in L sows.

Key Words: Gonadotropin, Estrus, Sow

595 Effect of acetate to propionate ratio on clearance of progesterone in the ovid. D. L. Smith*, B. A. Costine, and M. E. Wilson, *West Virginia University, Morgantown.*

The objective of these experiments was to determine if a change in the ratio of acetate to propionate (A:P ratio) in hepatic portal blood, draining the gastrointestinal tract, can alter the metabolism of progesterone by the liver. Experiment 1; 4 crossbred, ewe lambs (BW 45.5 + 2.5 kg) were fed for maintenance and given a once daily oral bolus (0.146 Mcal/d) of acetate (0.7 moles) or propionate (0.4 moles) for 11 d. A portal-vein catheter was inserted 14 d prior to collection. Portal and jugular venous blood were simultaneously collected (-0.17, 0.17, .33, 0.5, .66, .83, 1, 1.17, 1.33, 1.5, 1.66, 1.83, 2, 2.33, 2.66, 3, 4, 5, 6, 7 h with respect to feeding and VFA bolus) and serum was analyzed for concentrations of VFA by GLC. Experiment 2; 30 crossbred ewe-lambs, (BW 45.2 + 1.9 kg) were blocked by BW and fed for maintenance for 11 d. On d 12, each lamb was randomly assigned to one of two treatments, and given an oral bolus (0.146 Mcal/d) of acetate (0.7 moles) or propionate

(0.4 moles). Animals received (i.m.) 20 mg progesterone (P₄) in corn oil. Plasma samples were collected (-0.5, 0.5, 1, 2, 3, 4, 5, 6, 8 h relative to feeding, VFA bolus, and P₄ injection) via jugular venipuncture and circulating concentrations of P₄ were determined by P₄-RIA. An oral bolus of acetate or propionate caused a mark change in the A:P ratio for at least 4 h. By 24 h after the oral bolus, the A:P ratio returned to baseline. Plasma concentrations of P₄ after the oral bolus of either acetate or propionate began to diverge as early 0.5 h and were different ($P < 0.05$) by 3-h (1.09 + 0.09 ng/ml vs. 2.04 + 0.48 ng/ml) and 4-h (1.20 + 0.09 ng/ml vs. 1.95 + 0.41 ng/ml) for ewe lambs bolused with acetate and propionate, respectively. By 5 h, coincident with the return to baseline A:P ratios seen in Experiment 1, circulating concentrations of P₄ were not different. Changes in the A:P ratio altered the circulating concentrations of P₄ by reducing the metabolic clearance of P₄ when the A:P ratio was decreased.

Key Words: Acetate, Propionate, Progesterone

Production, Management and the Environment: Heat Stress and Environment

596 Response of heat stressed dairy cattle to low-pressure soaking or high-pressure misting heat abatement systems. M. J. Brouk*¹, J. P. Harner, III², J. F. Smith¹, W. F. Miller¹, and B. Cvetkovic¹, ¹*Department of Animal Sciences and Industry, Kansas State University,* ²*Department of Agricultural and Biological Engineering, Kansas State University.*

Eight lactating Holstein cows (4 primiparous and 4 multiparous) were arranged in a replicated 4x4 Latin square design to evaluate the effect of three different heat abatement systems. Respiration rate and surface temperature (right shoulder, left shoulder and rear udder) were measured and recorded at 5-min intervals during the study. Surface temperatures were measured with an infrared thermometer. Body temperature was recorded with a vaginal probe once per min and averaged by 5 min intervals prior to data analysis. Animals were housed in freestall barns and milked 2x. During testing, cattle were moved to a tiestall barn for a period of 2 hr starting at 14:00 hr on 4 days of intense heat stress. Treatments were control (C), low-pressure soaking applied for 1 min on 5 min intervals (LPS), continuous high-pressure misting with 2 (6.4 L/hr) nozzles (HP-2) or continuous high-pressure misting with 4 (6.4 L/hr) nozzles (HP-4). In addition to water application, all cooling treatments had supplemental airflow (215 m/min). Cows cooled by the LPS or HP-4 system became soaked during the 85 min the cooling treatments were applied. Respiration rates were lowered ($P < 0.05$) when cows were cooled (114.4, 98.2, 89.3 and 82.5 breaths per min for C, HP-2, HP-4 and LPS treatments, respectively). Cows cooled with either LPS or HP-4 had lower ($P < 0.05$) respiration rates than those cooled by HP-2. Surface temperatures of the right and left shoulders were lower ($P < 0.05$) for cooled cows as compared to controls. Cows cooled by HP-4 had lower ($P < 0.05$) shoulder surface temperatures than those cooled by HP-2 or LPS. Rear udder surface temperature was also lower ($P < 0.05$) for cows cooled by either HP-4 or LPS as compared to controls. Respiration rates were decreased by 14, 37 and 48% for HP-2, HP-4 and LPS cooling systems, respectively, during the 85 min evaluation period. The combination of cooled respiratory air and surface soaking of the HP-4 treatment was more effective in reducing shoulder surface temperature than LPS. These data suggest that soaking of cattle with either the LPS or HP-4 treatment provided superior heat abatement as compared to HP-2 or C.

Key Words: Heat Stress, Cow Cooling, Facilities

597 Impact of air velocity and direction of flow upon respiration rate, body surface temperature and body temperature of heat stressed dairy cattle. M. J. Brouk*¹, J. P. Harner, III², J. F. Smith¹, W. F. Miller¹, and B. Cvetkovic¹, ¹*Department of Animal Sciences and Industry, Kansas State University,* ²*Department of Agricultural and Biological Engineering, Kansas State University.*

Seven heat stressed, mid-lactation Holstein cows averaging 250 days in milk and producing an average of 38.3 kg of milk were arranged in a 7x7 Latin square design to determine the effects of air velocity and direction of flow on cow cooling. Animals were housed in freestall barns and milked 2x. Cows were moved to a tiestall barn for a period of 2 hr at

14:00 hr each afternoon of testing. Respiration rate and surface temperatures were measured and recorded at 5-min intervals during the 2 hr testing period. Surface temperatures were determined with an infrared thermometer and body temperature was measured and recorded once per min with a data logger and vaginal probe and subsequently averaged by 5-min intervals prior to data analysis. Treatments were control (C) or one of six different cooling treatments. All cooling treatments included a low-pressure soaker system which soaked the cows for 1 min on 5-min intervals. Supplemental airflow was provided by axial flow fans at one of three flow rates; 183 (1), 229 (2) or 275 (3) m/min. Airflow was either from the front to rear (FRT) or from the right side (SIDE) of the animal. Cooling treatments were FRT-1, FRT-2, FRT-3, SIDE-1, SIDE-2 or SIDE-3. Respiration rates were lowered ($P < 0.01$) by all cooling treatments as compared to controls. Cows cooled with SIDE-3 had lower ($P < 0.01$) respiration rates than cows cooled with FRT-1 or SIDE-2. Rear udder surface temperature was lowered ($P < 0.05$) when cows were cooled by FRT-3, SIDE-2 or SIDE-3 as compared to the controls. Right shoulder temperature was reduced more compared to left shoulder temperature when the airflow was from the right side as opposed from the front. The impact of air velocity on surface temperature was variable, but more predictable when from the front as opposed to the side of the animal. These data indicate that the velocity and direction of supplemental airflow elicit different responses from heat stressed dairy cows. Airflow from the front to the rear of the animal may result in greater cooling than air directed at the side of the animal.

Key Words: Heat Abatement, Facilities, Cow Cooling

598 Impact of soaking cows housed in a tunnel ventilated barn equipped with evaporative pads located in Thailand. D. V. Armstrong¹, J. F. Smith*², M. J. Brouk², V. Wuthironarith³, and J. P. Harner, III², ¹*University of Arizona, Tucson,* ²*Kansas State University, Manhattan,* ³*Charoen Pokphanol Group Co., LTD, Bangkok, Thailand.*

Ten lactating Holstein cows (10 multiparous) were arranged in a replicated 5 x 5 Latin Square design to evaluate the effect of soaking frequency and volume of water per soaking on lactating cows housed in tunnel ventilated and evaporative cooled freestall barn. Rectal temperature, respiration rate and body surface temperature (shoulder, thurl and rear udder) were measured every 5 minutes. Treatments were control (C), soaking every 5 min with 1L (5+1) or 2L (5+2), and soaking every 10 min with 1L (10+1) or 2L (10+2). Average ambient temperature and humidity were 30.3°C and 68% and 26.9°C at 86% in the barn. Water was applied manually from the shoulder to the tail and had a temperature of 27°C. Treatments were applied after 3 initial measurements were taken. Seventeen measurements were taken during treatment application and 5 measurements were taken after the treatments were stopped. Air velocity over the shoulder of the cows was 110 m/min. Respiration rate and body surface temperature for all treatments were lower than the control except for rear udder surface temperature of 1+10. Rectal temperature for 1+5, 2+5, and 2+10 were lower than the control. Respiration rate for 1+5 and 2+5 were lower than 1+10. These data suggests that soaking can be used in combination with tunnel ventilation and evaporative pads to reduce heat stress.

Treatments	C	1 + 5	2 + 5	1 + 10	2 + 10	SE
Respiration rate, Breaths/min.	72.8 ^a	51.0 ^c	51.6 ^c	59.3 ^b	55.6 ^{b,c}	2.03
Rectal Temperature, °C	38.5 ^a	38.2 ^b	38.2 ^b	38.3 ^{ab}	38.2 ^b	0.12
Body Surface Temperature, °C						
Thurl	34.4 ^a	32.0 ^c	31.8 ^c	32.6 ^b	32.3 ^b	0.38
Rear Udder	35.3 ^a	34.6 ^b	34.7 ^b	35.0 ^{ab}	34.8 ^b	0.25
Shoulder	34.3 ^a	32.1 ^{b,c}	31.9 ^c	32.9 ^b	32.7 ^b	0.50

^{abc}Means within a row that have different superscripts are different $P < 0.05$.

Key Words: Heat Stress, Cooling Systems, Facilities

599 Effects of shade, sprinklers, and stocking density on performance, behavior, physiology, and environmental impact of Holstein heifers in drylot pens. N. M. Marcillac*, P. H. Robinson, J. G. Fadel, and F. M. Mitloehner, *University of California, Davis*.

The objective of the study was to measure the effects of shade, sprinklers, and stocking density on performance, behavior, physiology, and environmental impact of 40 Holstein heifers, housed in dirt-floored drylot pens during summer. Experimental design was a 4 x 4 Latin square, using 21-d periods and treatments: 1) shade, no sprinklers, normal (100%) stocking density; 2) no shade, sprinklers, normal stocking density; 3) shade, no sprinklers, increased (130%) stocking density; and 4) no shade, sprinklers, increased stocking density. Performance measures included DMI, ADG, and gain:feed. Ethologic measures were laying, standing, walking, feeding, drinking, bulling, agonistic, urination, and defecation behavior. Physiological measures were rectal temperature, respiration rate, urinary urea nitrogen (UUN), blood urea nitrogen (BUN), fecal carbon and energy. Environmental measures were manure composition, surface temperature, surface moisture, particulate matter #8804 10 or 2.5 μm (PM10 and PM2.5, respectively), and surface flux chamber ammonia concentrations. Shaded vs sprinkled heifers tended to have increased DMI ($P = 0.07$), decreased gain:feed ($P < 0.05$), but similar ADG, while stocking density had no effect on performance. Heifers spent most time and showed highest frequency of daytime elimination behaviors in either the shaded ($P < 0.05$) or sprinkled areas ($P < 0.05$) of their pens. Heifers in pens with normal vs increased stocking density showed increased bulling and standing behavior ($P < 0.05$). Respiration rate was decreased ($P < 0.01$) in shaded vs sprinkled heifers, but rectal temperature, BUN, UUN, and fecal carbon was similar across treatments. Shaded or sprinkled areas within each pen had highest surface moisture ($P < 0.05$), and lowest surface temperature ($P < 0.05$). Shaded vs sprinkled pens showed decreased ammonia ($P < 0.05$), increased PM10 ($P < 0.05$) and similar PM2.5 concentrations. In conclusion, only shade improved heifer performance, and both shade and sprinkling inversely affected ammonia and PM10 emissions from drylot pens.

Key Words: Heat Stress, Environment, Cattle

600 The effect of fiber characteristics on production, physiological and behavioral traits in heat stressed dairy cows. A. Arieli*¹, A. Rubinstein¹, Y. Ahroni², U. Moallem², and I. Halachmi², ¹Fac. of Agric., Hebrew University of Jerusalem, Rehovot, Israel, ²Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel.

A trial was conducted using 40 mid-lactating (141 DIM) cows to evaluate the effect of fiber characteristics on production, physiological and behavioral traits in heat stressed dairy cows. The trial was conducted during summer 2003, in Bet Dagan, Israel. The mean, and maximal ambient temperature, relative humidity and thermal humidity index prevailing throughout the trial were: 26 and 31°C, 63 and 92%, and 75 and 82, respectively. Cows had 3 showers/d in the milking waiting yard; each lasting for 20 min. Cows were individually fed, receiving a low CP diet (15% CP), 33% RUP (% of CP), 33% NDF. The cows were blocked into 2 dietary treatments: Control (CON) and treatment (TRT) groups received 18% and 12% NDF in the DM from forage sources. In the TRT

group 2 kg of wheat hay was replaced by the same amount of soyhulls. Milk yield and composition were measured daily, and every 2 wks. Feed intake was measured continuously by a computerized system. The heart rate was measured in ten cows per group during a 3 d period, and energy expenditure was estimated by calibrating heart rate with oxygen consumption by applying the open mask method. In both groups the initial DM intake was 25 kg/d, and decreased by 80 g/d. Mean meal size was 1.7 kg of DM/meal in both groups, but feeding time was higher (14 min) in CON than in TRT (12 min, $P < 0.001$). Initial milk yield was 37 kg/d in both groups; milk yield decreased by 120 g/d in both groups. Concentrations of milk protein and lactose were 3.08 and 4.80% in both groups, whereas fat concentration was 3.30% in TRT and 3.02% in CON ($P < 0.05$). Mean energy expenditure was 1025 kJ/MBW-d in both groups. Energy expenditure varied during the day, being highest at 1900h (1063 and kJ/MBW-d) and lowest at 0800h (996 and kJ/MBW-d, $P < 0.05$). It was concluded that replacing forage NDF with NDF from non forage source, like soyhulls, is not an efficient means to reduce metabolic heat production in heat stressed cows.

Key Words: Dietary Fiber, Heat Stress, Feeding Behavior

601 Changes in the diurnal rhythm of rectal temperature of cattle exposed to prolonged heat stress, and cooled with warm salt water. J. Gaughan*¹ and S. Holt², ¹The University of Queensland, Gatton, Australia, ²South Dakota State University, Brookings.

This study was undertaken in a controlled climate facility using 6 Angus steers in individual stalls. This study investigated changes in rectal temperature (RT) in cattle exposed to thermoneutral conditions (TN) for 4 d and hot conditions (HOT) for 11 d. During HOT cattle were wetted for approximately 60 s when RR equalled or exceeded 120 breath per minute using a hose. Warm (30 °C) salt water (3% NaCl) was used. Individual RT was measured every 60 s. Dry bulb temperature, wet bulb temperature, relative humidity and air movement were recorded every 10 min. For all steers mean daily RT were lower ($P < 0.01$) on days 1 to 4 than for 5 to 15. During HOT, individual mean daily RT on day 5 were lower than mean daily RT for days 6 to 15. Rectal temperatures increased over the first 4 d and then decreased slightly. Individual rectal temperatures varied over a 24-hour period, but remained fairly constant (± 0.1 °C variation) for up to 6 h each day. During HOT, small incremental rises in RT were additive. There was no consistency in the rise, with daily increases of 0.5 °C followed the next day with a 0.01 °C increase. Decreases in RT also occurred but at no time did RT return to levels of TN. Minimum RT is an important measure. Clear diurnal patterns were seen for RT over the first 8 to 9 d of HOT but not on days 10 and 11. There is also evidence of reduced diurnal movement (day 8, 10 and 11) suggesting that the cattle were not dumping their heat load, and may be an indicator of failure to cope. Diurnal patterns seen in previous studies were usually associated with significant diurnal changes in climatic conditions. It is possible that cattle accumulate heat during the hotter parts of the day and then dissipate this heat when conditions are cooler. These data suggest that cattle will use this mechanism even where diurnal variations in climatic conditions are small or non-existent but will reach a point where the mechanism fails largely because the ambient conditions do not alleviate.

Key Words: Heat Stress, Rectal Temperature, Beef Cattle

602 Emissions of atmospheric ammonia and a nitrogen mass balance for a dairy. B. P. Rumburg*¹, G. H. Mount¹, J. M. Filipy¹, B. K. Lamb¹, R. L. Kincaid², and K. A. Johnson², ¹Laboratory for Atmospheric Research, Department of Civil & Environmental Engineering, Washington State University, Pullman, ²Department of Animal Sciences, Washington State University, Pullman.

Atmospheric ammonia (NH₃) emissions have many impacts on the environment and human health. The global emissions of NH₃ are estimated to be 45 Tg N yr⁻¹ (Dentener and Crutzen, 1994). Most emissions come from domestic animals with the largest per animal emission coming from dairy cows at 3 times the beef cow rate. The main sources of emission from US dairies are the cow stalls where urea and manure react to form NH₃, the storage lagoons where NH₃ is the end product of microbial degradation and waste disposal. Numerous studies of NH₃ emissions performed in Europe do not apply to the US due to differences in farming practices. We have been studying the NH₃ emissions from the WSU

dairy for four years to develop a detailed emission model from each dairy source for use in a Pacific Northwest regional air quality model. NH₃ concentrations are measured using open path differential optical absorption spectroscopy in the mid- ultraviolet where NH₃ photoabsorbs near 220 nm. The instrument consists of a Xe lamp, a sending and receiving telescope, retro reflectors and a multiplexing spectrograph and data acquisition hardware (Mount et al., 2002). The method is self calibrating and avoids inlet wall adherence which is a major source of error in NH₃ measurements. An SF₆ tracer technique has been used to convert measured NH₃ concentrations to fluxes from the three main dairy emission sources. The SF₆ is released at a measured rate upwind of the source and both the tracer and NH₃ are measured downwind. A ratio of the SF₆ and NH₃ concentrations and the SF₆ flux along with a stability and area factor gives the NH₃ flux.

NH₃ fluxes from the dairy cow stalls area average 0.4 mg m⁻² s⁻¹ and the flux from the dairy lagoon averages 50 ug m⁻² s⁻¹. Waste application with a "Big Gun" sprinkler resulted in 17% volatilization from the sprinkler alone. Total NH₃ emissions from the WSU dairy are 170 ± 50 kg cow⁻¹ yr⁻¹ while current EPA estimates are 40 kg cow⁻¹ yr⁻¹. Emission rates will be compared in detail to a nitrogen mass balance of the feed inputs and milk and animal outputs at the dairy.

Key Words: Ammonia, Dairy, Emission

603 Effects of dietary crude protein level on nitrogen balance and emissions. H. A. Rachuonyo*, S. E. Curtis, E. O. Castaneda, and M. Ellis, *University of Illinois, Urbana.*

Two studies were conducted; one in dynamic air flow chambers (DAFC; exposure zone 64 ft³), the other using metabolic crates, to determine amounts of N losses and evaluate N digestibility and excretion using growing pigs fed either 14.5 (LCP) or 18.5% (HCP) CP diets (similar levels of digestible lysine-0.83%). In *Study 1*, 8 barrows (initial mean BW 17.9±0.97 kg) were randomly assigned in pairs to 4 DAFC and diets; with 3 replicates over time. Air in chambers was kept under positive static pressure at 0.32 inches H₂O with constant ventilation rate of 30 cfm. Feed and water were provided *ad libitum*. Pigs were acclimated for 7 d, followed by a 2-wk sampling period. Pigs and feeders were weighed weekly. In *Study 2*, twelve barrows/diet (initial mean BW 17.7±1.32 kg) were randomly assigned to individual crates and diets, and were fed at 90 % of *ad libitum* intake. Acclimation for 5-d was followed by 5-d collection of feces and urine (analyzed for N). In *Study 1*, BW, ADFI, ADG, gain:feed, water usage, odor threshold, and hydrogen sulfide levels did not differ between diets (P>0.05); however, slurry pH (6.1 vs. 6.8, SEM=0.05) and ammonia concentrations (0.4 vs. 1.8 ppm; 0.03) as well as ammonia emission rate (2.8x10⁻⁴ vs. 1.2x10⁻³ g/min; 1.73x10⁻⁵) were higher (P<0.05) for HCP than LCP diet. In *Study 2*, there were no differences in BW, ADG, ADFI, or urine output due to diet. Nitrogen in feed, feces, and urine and N intake were higher (P<0.05) for HCP than LCP diet (2.3 vs. 3.5%, 0.02; 3.0 vs. 3.7%, 0.16; 0.1 vs. 0.2 g/100 ml, 0.01; and 16.0 vs. 24.5%, 0.25, respectively). Total N excreted, retained, and balance also were higher (P<0.05) for HCP than LCP (6.7 vs. 12.0 g/d, 0.25; 41.8 vs. 49.2%, 1.28; 9.4 vs. 12.5 g/d, 0.31, respectively); however net protein utilization and biological value were greater (P<0.05) for LCP than HCP diet (58.2 vs. 50.9%, 1.29 and 71.8 vs. 59.7%, 1.33, respectively). Results indicate that CP level in diet influences N excretion, retention, utilization as well as slurry pH and N emissions.

Key Words: Crude Protein, Nitrogen Balance, Ammonia Emission

604 Calcium clinoptilolite zeolite added to the diet to reduce nitrogen losses from feedlot lagoons and composted manure. K. S Eng*¹, R. Bectel², and D. P. Hutcheson³, ¹Eng, Inc., San Antonio, TX, ²Advance Agricultural Testing, Baden, ON, Canada, ³Animal-Agricultural Consulting, Inc., Amarillo, TX.

Rapid nitrogen (N) loss and ammonia emissions from feedlot manure and lagoons represent a loss in fertilizer value and a potential environmental problem. Composting feedlot manure may reduce odors, but additional N is lost during the composting process. Previous research has shown that Biolite (BLT) a specific calcium clinoptilolite zeolite (CZ) added to feedlot diets can reduce manure N losses. The study was designed to compare a high concentrate steam flaked corn-wet gluten corn silage finishing diet with or without 1.2% CZ (DMB) fed to feedlot steers on concrete floors. The CZ was added in place of an equivalent amount of grain. In the lagoon study 20 gallons of fresh liquid manure adjusted to

a 10% dry matter content was added to 100 gallon sealed vertical plastic containers. Ammonia content of the trapped air was measured each day, after which the air was evacuated and the container re-sealed. No additional manure was added to the system. The ammonia concentration measured would be daily not accumulated ammonia production. Ammonia production was greater and increased more rapidly in the control compared to the CZ treatment. In both treatments, ammonia production peaked at nine days and was 110 and 57 ppm for the control and CZ treatments, respectively. Ammonia production for each treatment appeared to increase with increasing ambient temperatures. Composted treatments consisted of wet manure collect for four days from the control and CZ diets, mixed with 1/3 sawdust and composted for ten weeks. Samples from each treatment were obtained on day one and at one to two week intervals thereafter and analyzed for moisture, N and phosphorus (P). N loss from the compost was reduced in the CZ treatment and the N: P ratio increased. Compost N loss at weeks 6 and 7 was 27.3% for the control compared to 14.7% for the CZ treatment. The results indicate 1.2% CZ added to a feedlot finishing diet significantly reduces lagoon ammonia and composted manure N losses, Table1.

Treatment	Time	Dry Matter %	N	% Lost	P	N:P
Control	Day 1	35.1	2.05		1.00	2.05
Control	Week 2-3	37.8	1.95	-4.88	0.95	2.05
Control	Week 4-5	51.3	1.59	-22.44	.96	1.66
Control	Week 6-7	51.5	1.49	-27.32	.89	1.67
Control	Week 9-10	48.2	1.50	-26.83	.88	1.70
CZ	DAY 1	35.3	2.11		1.04	2.03
CZ	Week 2-3	49.6	1.93	-8.53	1.02	1.89
CZ	Week 4-5	49.8	1.8	-14.69	.93	1.94
CZ	Week 6-7	50.3	1.8	-14.69	1.00	1.80
CZ	Week 9-10	47.6	1.87	-11.37	.98	1.91

Key Words: Ammonia, Zeolite, Feedlot

605 Combination of a urease inhibitor and a plant essential oil for control of fecal coliforms and emissions of odor and ammonia from cattle waste. V. H. Varela*, J. E. Wells, and D. N. Miller, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

A 2002 report from the National Research Council of the National Academies ranked ammonia and odor as their highest concerns for emissions from confined animal feeding operations. Most of the ammonia emissions in livestock wastes originates from hydrolysis of urea, whereas odor emissions originate from microbial production of VFA from waste organic matter. The objectives of this work were to evaluate urea hydrolysis, VFA production (odor), and fecal coliforms in cattle waste slurries after a urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT) and a plant oil (thymol) were added. Feces, urine and distilled water in the ratio 50:35:15 were blended for 1 min. Triplicate aliquots of 750 ml were amended with chemical additives and rebled for 1 min, and were poured into 1.6 L wide-mouth jars covered 90% with a lid. After 56 days, thymol (2000 mg/kg waste) in combination with NBPT (80 mg/kg waste) retained 5.2 g of an initial 8 g of urea in cattle waste slurries, compared to less than 1 g of urea retained when NBPT was the only additive (P < 0.05). Thymol by itself had no inhibitory effect (P > 0.05) on urea disappearance. However, thymol or thymol in combination with NBPT reduced VFA production (P < 0.01), but NBPT had no effect (P < 0.05) on VFA production. Thymol and thymol with NBPT also eliminated all fecal coliforms after one day. Fecal coliforms disappeared in the no addition treatment after 8 days; however, they were viable at 6.6 × 10⁴ cfu/g waste beyond 35 days in the NBPT treatment. These results indicate thymol has an additive effect to NBPT by further inhibiting hydrolysis of urea in cattle waste slurries and increasing nitrogen retention in the waste. Also NBPT appears to interfere with the normal eradication of fecal coliforms in cattle waste slurries.

Key Words: Plant Oils, Urease Inhibitor, Cattle Waste

606 Evaluation of factors affecting phosphorus solubility in feces of lactating cows. T. D. Nennich*¹, J. H. Harrison¹, Z. Dou², L. Johnson VanWieringen¹, R. L. Kincaid³, and D. L. Davidson¹, ¹Washington State University, Puyallup, ²University of Pennsylvania, Kennet Square, ³Washington State University, Pullman.

Solubility of fecal P is associated with potential movement of P to surface waters after field application. The objective of this study was to evaluate factors affecting total and soluble P excretion by lactating dairy cows. Fecal samples (n = 121) were from total collection metabolism studies that used multiparous Holstein cows. These samples were analyzed for water soluble P by extraction (0.3 g + 100 ml deionized water) and P soluble in dilute acid (0.3 g + 100 ml 0.1% HCl). Variables evaluated in regression equations included P intake, dietary P concentration, Ca:P ratio, Ca intake, and other animal and dietary factors. Regression analysis performed using the PROC MIXED procedure of SAS included study as a random variable. Total P and HCl soluble P excretion were predicted using dietary P concentration, whereas dietary P concentration was not a significant variable for predicting water soluble P. Water-soluble P in the feces was affected by P intake and the concentration of Ca in the diet. Increased ratios of dietary Ca:P decreased soluble and total P excretion. Equations developed to predict water or HCl soluble fecal P (g/kg) using Ca:P ratio as the independent variable were $y = -0.75 (\pm 0.16) \times \text{Ca:P (g)} + 4.32 (\pm 0.40)$ and $y = -0.51 (\pm 0.40) \times \text{Ca:P (g)} + 7.56 (\pm 1.07)$, respectively. Dietary or animal factors in several of the studies evaluated affected total and soluble P excretion. In one study on maturity of corn silage, cow diets that contained 37% corn silage (DM basis) resulted in an average P balance of -32 g and had greater total P and HCl-soluble P excretion than other studies at similar dietary P concentrations. A better understanding of dietary factors that contribute to greater soluble P excretion in feces will aid in formulating diets to help lower the excretion of soluble P in feces.

Key Words: Phosphorus, Calcium, Feces

607 Separated drinking water from liquid manure for swine. J. Morris*, R. Fleming, and M. MacAlpine, *Ridgetown College, University of Guelph, Guelph, ON, Canada.*

The efficacy of separated clean water from liquid swine manure as a source of drinking water for starter pigs was completed. The objectives of the study were to evaluate the impact of separated clean water as a source of drinking water on the quality of water, the growth performance and the health status of starter pigs. Water was recovered from liquid manure using the Vibratory Shearing Enhanced Processing (VSEP) unit which was fitted with an reverse osmosis (RO) filter pack. The quality of the recovered water (permeate) was assessed and provided for drinking water to young pigs. Three water treatments (A-regular barn water,

B-half barn water and VSEP permeate, and C-VSEP permeate) were prepared and given to the pigs. A total of 54 pigs were allocated to 9 pens of 6 pigs each (3 barrows and 3 gilts). All pigs were fed ad libitum a pelleted corn-soybean meal based pig starter ration. The pigs were subjected to the water treatments for 28 days (12 - 26 Kg liveweight). Performance data was subjected to statistical analysis using the GLM procedure of SAS. Results showed that the VSEP unit produced permeate (separated water) from liquid manure at a quality level acceptable to pigs. No significant treatment effects were found for ADFI - 1.20, 1.18, and 1.23kg/d; se = 0.04; p=0.755, ADG - 0.50, 0.52 and 0.51kg/d; se=0.009; p=0.579, Feed-to-Gain conversion - 2.38, 2.20, and 2.40; se=0.095 and daily water intake - 5.2, 4.3, and 6.1 l/d; se=0.492; p=0.099, for water treatments A, B and C respectively. There were no negative health effects resulting from the treatments during the study. It appeared that the recovered water from liquid manure under the conditions of this study was satisfactory as a source of drinking water for starter pigs.

Key Words: Swine, Water, Liquid Manure

608 Environmental impact of integrating crop and sylvan systems with swine. C. W. Talbott*¹, G. B. Reddy¹, C. Raczkowski¹, T. Barrios¹, M. Matlapudi¹, A. Coffee², and J. Andrews², ¹North Carolina A&T State University, Greensboro, ²USDA/CSREES Forestry, NC Division of Forest Resources, Raleigh, NC.

Many species of swine evolved in sylvan environments where natural canopies provide cooler temperatures and thereby aid in thermoregulation during the warm seasons. During cooler seasons, farmers may be able to develop organic soils by utilizing the rooting behavior of the hogs to incorporate manure and mulch into compost. Forty-eight gestating sows were randomly assigned to one of six 25m x 90m wooded plots or one of four 40m x 30m dirt-lots for warm season application (April through September). Five, 10 m radius areas were surveyed (inches diameter breast high, basal area, % canopy) for species variation and prevalence after two, six-month seasons with swine; timber growth response was adjusted for animal stocking rate. During the cool season (October through March), animals were rotated to eight, 20m x 20m lots with or without leaf mulch. Soil samples were collected in years 2000 and 2001 at planting and at harvest at depth increments of 0-15 cm, 15-30 cm and 30-60 cm. Samples were analyzed for soil NO₃-N, inorganic N, PO₄, total P, organic matter, total C, total N, C:N, and CEC. Integrated plots with pigs had significant increases in NO₃-N, inorganic N and PO₄ concentrations. Results suggest that sylvo-pastoral systems with swine may improve hardwood stands by reducing softwood competition.

Key Words: Integrated Systems, Sylvo-Pastoral, Swine

Ruminant Nutrition: Dairy - Additives, Vitamins & Models

609 Effects of *Aspergillus oryzae* (Amaferm®) on production and metabolic parameters in Holstein cattle during the transition period. L. H. Baumgard*¹, M. E. Dwyer¹, C. Davis¹, C. E. Moore¹, H. C. Haffiger III¹, O. B. Mendivil¹, H. Jensen², B. Christie², and M. J. VanBaale¹, ¹The University of Arizona, Tucson, ²BioZyme Inc., St. Joseph, MO.

Holstein cattle (n=33; 22 multiparous and 11 primiparous) were assigned to a TMR with or without an *Aspergillus oryzae* (AO) extract (Amaferm®; BioZyme Inc., St. Joseph, MO) from -21 to 60 d relative to calving. Alfalfa hay was the main forage source and steam-flaked corn the primary concentrate. AO (15 g/cow/d) was top-dressed daily at 0600 h. Cows were balanced by previous 305 ME and heifers randomly assigned to treatment, all animals were blocked by calving date and milked at 0600 and 1800 h, yield was recorded daily, and milk and blood samples were obtained 1, 7, 14, 21, 28 and 35 DIM. Body weights (BW) were recorded weekly until 60 DIM. There was no overall effect of treatment or treatment by week interaction on DMI prepartum (18.3 kg/d) or postpartum (39.7 kg/d), and this was independent of parity. BW loss did not differ between treatments (51.9 kg), but AO tended (P<0.1) to reduce week of BW nadir (5.0 vs. 6.2 wk). There were no interactions between parity and treatment on BW change, but overall, heifers lost less BW (31.8 vs. 71.8 kg) and tended (P<0.1) to reach BW nadir earlier than cows (4.9 vs. 6.2 wk). Feeding AO through the transition increased (P<0.05) milk yield (35.0 vs. 37.7 kg/d). The overall

treatment effect was attributed to the enhanced milk yield of cows (40.8 vs. 44.7 kg/d) as heifers had similar milk yields between treatments. Peak yield was achieved earlier (wk 3) in AO compared to control fed cows (wk 5-6) and this resulted in a milk differential of 4.5 kg during wks 3 and 4 of lactation. AO tended (P<0.15) to increase milk fat content (6%) and decrease milk lactose percentage (3%). Plasma glucose concentrations were not altered by treatment. Despite increased milk yield without a corresponding increase in feed intake, plasma NEFA levels tended (P<0.12) to be reduced (14%) by AO. Feeding an AO extract through the transition appeared to increase dietary energy availability and improve production.

610 The effects of feeding yeast culture during the transition from cool to hot weather to Holstein cows on animal performance. J. D. Ward*¹, T. R. Smith², L. Zeringue¹, R. J. Williams², J. Crouch², R. Walz¹, T. Nuefech², and H. M. Wilson², ¹LSU AgCenter, Southeast Research Station, Franklinton, LA, ²Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State.

Forty-two mid to late lactation Holstein cows at two locations were used to determine the effects of feeding yeast culture during the transition from cool to hot weather on dry matter intake (DMI), milk production (MP), blood glucose, body condition score (BCS) and body weight

(BW). Cows were housed at the Mississippi State University dairy (MS; n=23) and the LSU AgCenter Southeast Research Station dairy (LA; n=19). Both groups of cows were housed in free stall barns and individually fed using Calan gates (American Calan, Northwood, NH). The cows at MS were fed a totally mixed ration while those at LA were component fed with forage and grain offered separately. Cows received yeast culture as a top dress on their feed (113 g/d). Milk production and DMI were recorded daily. Blood samples were taken weekly for plasma glucose analysis. Body weight and BCS were recorded at the beginning and end of the eight week study. Milk production and DMI data were averaged within week before statistical analysis. There was a treatment by parity interaction for MP with yeast supplementation decreasing MP in primiparous cows ($P < 0.08$; 31.1 vs 26.4 kg/d) but increasing MP in second and later lactation cows ($P < 0.08$; 29.7 vs 25.1 kg/d). There was also a treatment by parity interaction for DMI with yeast supplementation decreasing DMI in primiparous cows ($P < 0.08$; 20.5 vs 22.1 kg/d) but increasing DMI in third lactation cows ($P < 0.10$; 23.4 vs 20.0 kg/d). Dietary treatment had no effect on plasma glucose, BW, BCS, nor changes in BW and BCS. The results of this research indicate that feeding yeast culture during the transition from cool to hot weather can improve animal performance in second and later lactation cows but may be detrimental to primiparous cows. Further research is needed to determine why primiparous cows respond differently than older cows to yeast supplementation.

Key Words: Yeast Culture, Heat Stress, Milk Production

611 Effects of feeding yeast culture on milk yield during heat stress conditions. F. Y. Bernal*, J. S. Britt, J. W. Tako, and N. C. Speer, *Western Kentucky University, Bowling Green.*

Effects of feeding yeast culture on milk yield during heat stress conditions. F.Y. Bernal, J.S. Britt*, J.W.Tako, N.C. Speer, Western Kentucky University

The objective of this study was to evaluate the effect on milk yield of dietary yeast 2x-2-2-5 fed to lactating dairy cows during heat stress conditions. Sixteen cows per group paired by breed (Jersey and Holstein), lactation number and days in milk were assigned to CONTROL (no yeast) or YEAST 2X-2-2-5 PLUS (2oz - 2-2-5 western yeast) group. Both groups were fed a total mixed ration consisting of corn silage, alfalfa haylage, alfalfa hay, grain mix including whole cottonseed and also had controlled access to alfalfa pasture. The trial ran between August 6 and September 16. Dry matter content of the TMR fed and the refusal was measured to calculate dry matter consumption. Cows were weighed 3 times during the trial. Body temperatures were taken at each weighing. Milk weights were captured at each milking using electronic weigh meters, which download into a computer. Data was analyzed using Microsoft Excel and 7-day average milk weights were used in the analysis. Both groups were subject to the same heat stress conditions. Individual animal milk fat and protein percent was determined by laboratory analysis three times during the trial. During the trial 1 cow from each group had to be removed for health reasons. The matching paired cow from the other group was removed so the final results were based on 14 cows per group. Milk yield, butterfat %, butterfat yield, protein yield, fat corrected and energy corrected milk were not statistically but were biologically higher, FCM 4.78 lbs/day and ECM 4.15 lbs/day, in the YEAST 2X-2-2-5 PLUS group than the CONTROL group. At 13/CWT there was a 0.54 economical advantage daily to the YEAST 2X-2-2-5 PLUS group. The YEAST 2X-2-2-5 PLUS group did have an advantage over the CONTROL group in faster recovery from a drop in milk production following an increase in ambient temperature.

Key Words: Yeast, Milk Yield, Heat Stress

612 Improving the fermentation and aerobic stability of bermudagrass with molasses or a combination of bacteria and enzymes. A. T. Adesogan*, N. A. Krueger, D. B. Dean, M. B. Salawu, and C. R. Staples, *University of Florida, Gainesville.*

This study determined the effectiveness for improving the fermentation and aerobic stability of bermudagrass, of an inoculant (BB), molasses, or a mixture of either BB and molasses (BBM) or BB and fibrolytic enzymes (BBE). A five-week regrowth of Tifton 85 bermudagrass was conserved in quadruplicate in mini-silos alone, or after treatment application. The inoculant contained a mixture of *Pediococcus pentosaceus* 12455, 1×10^5 cfu/g of fresh forage and *Lactobacillus buchneri* 40788, 4×10^5 of fresh forage and beta-glucanase, alpha-amylase

and xylanase. BBE contained similar enzymes as BB, but greater enzyme activities. Chemical composition was quantified after 2, 4, 7, 30 and 60 d of ensiling and microbial composition and aerobic stability were measured after 60 days of ensiling. After 60 d of ensiling, the pH of additive-treated silages was consistently lower ($P < 0.05$) and DM recovery was higher ($P < 0.01$) than in untreated silages. BB, BBM and molasses-treated silages had less ($P < 0.01$) ammonia N than untreated silages. BB, BBM, and BBE-treated silages had less ($P < 0.01$) residual WSC than untreated silages. All silages had high acetic acid (47.5 g/kg DM) and low lactic acid (1.7 g/kg DM) concentrations. However, untreated and BBE-treated silages had more ($P < 0.05$) butyric acid and ammonia N, suggesting that a clostridial fermentation had occurred. These butyric forages were more ($P < 0.05$) aerobically stable (27 d), but less desirable for feeding than those ensiled with BB or molasses, which were stable for 6.9 d. In conclusion, BB and molasses treatments improved the digestibility and fermentation of bermudagrass and produced higher quality silages that were stable for 6.9 days. Mixing BB with molasses or the enzyme tested was not more beneficial than BB or molasses alone.

Key Words: *Lactobacillus buchneri*, Silage, Inoculant

613 Use of exogenous proteolytic enzymes to improve lactational performance of dairy cows. J.-S. Eun* and K. Beauchemin, *Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

The effects of exogenous proteolytic enzymes (EPE) on digestibility and lactational performance were determined using 8 lactating Holstein cows in a double 4x4 Latin square experiment with a 2x2 factorial arrangement of treatments. Diets based on barley silage and alfalfa hay as the primary forage sources were formulated to obtain two forage to concentrate ratios (60:40 vs. 34:66, DM basis) using steam-rolled barley concentrate. Four dietary treatments were tested: HF-EPE = high forage without EPE, HF+EPE = high forage with EPE, LF-EPE = low forage without EPE, and LF+EPE = low forage with EPE. The EPE contained protease activity, but no measurable xylanase or endoglucanase activity. The EPE was added to the concentrate portion of the diets after pelleting at a rate of 1.25 mL/kg DMI. Data were analyzed using the PROC MIXED function of SAS. Increasing the forage proportion or adding EPE decreased intakes of DM and nutrients ($P < 0.01$). However, total tract digestibilities of DM and fiber were increased by decreasing the forage proportion or adding EPE ($P < 0.01$). Increases in digestibilities due to enzymes were highest with the LF+EPE diet. Digestibilities of DM, NDF, and ADF increased by 6.3%, 14.8%, and 23.6%, respectively. Feeding a LF diet increased digestible DMI ($P < 0.01$), but EPE did not influence digestible DMI because of the drop in DMI. Milk yield increased with feeding a LF diet (46.8 vs. 42.1 kg/d, $P < 0.01$), but decreased with adding EPE (43.4 vs. 45.5 kg/d, $P < 0.01$). Adding EPE to the LF diet increased milk fat percentage ($P < 0.01$), but not as much as increasing the forage proportion. Milk protein concentration was decreased when EPE was added to the LF diet ($P < 0.01$). Dairy efficiency calculated as milk/DMI was highest for the LF+EPE diet. Addition of EPE decreased nitrogen utilization for milk production for both the HF and LF diets ($P < 0.01$). Addition of EPE resulted in considerable improvement in the digestibility of nutrients, but the negative effects on intake offset these benefits.

Key Words: Exogenous Proteolytic Enzyme, Digestibility, Milk Yield

614 Effects of mixture enzymes on hydrolysis and rate of fermentation of alfalfa in vitro. A. A. Naserian* and S. Ghasemi, *Animal Science Department of Ferdowsi University, Mashhad, Iran.*

The use of enzymes as additives in ruminant diets has received considerable research interest and recently following positive responses observed in feeding trials, the objective of present study was to determine the effects of mixture enzymes on rate of fermentation of alfalfa in vitro. The gas production system consisted of 64 gas serum bottle (100mL) and one incubation chamber ($39 \pm 1^\circ\text{C}$) were used to hold the 64 serum bottle and bottle were continuously shaken with an orbital shaker. 0.2g of ground alfalfa (four replicate for one time) were weighted in to each bottle. The enzyme mixture (Natuzyyme, Bioproton PTY. LTD., AU) was applied at 4 levels (0, 2, 4, 8 g/kg alfalfa, air dry basis), then 20mL of rumen fluid and 10mL of buffer were added to each bottle and initial volume of each bottle was 30mL, gas production was measured for 96

hours (0, 2, 4, 6, 8, 12, 24, 48, 72, 96), the values corrected for the gas released from blank(rumen fluid+ buffer) and initial volume. Data were analyzed Using General Linear models procedures of SAS V6.12 for ANOVA to evaluate differences among experimental groups, means were compared with Duncan test. Enzyme had significant effect on gas production ($P \leq 0.05$), (Table 1). values for each treatment were averaged across replicates and equation $y = a + b(1 - e^{-ct})$ was employed to fit data, gas production rate and cumulative gas production were affected by enzyme supplementation ($P \leq 0.05$), (Table 1). In conclusion, adding of a fibrolytic enzyme mixture increased the rate of gas production.

Table 1.

Treatment	Control	1x	2x	4x	SEM
Gas production (mL)	29.3 ^c	29.96 ^b	30.27 ^a	29.75 ^b	0.051
a+b (mL)	47.8 ^c	48.5 ^b	48.9 ^a	47.7 ^d	0.001
C (h ⁻¹)	0.102 ^d	0.1039 ^b	0.1035 ^c	0.1055 ^a	0.0001

Key Words: Mixture Enzyme, Fermentation, Gas Production

615 Effect of fibrolytic enzymes on the fermentation characteristics, aerobic stability and digestibility of bermudagrass silage. D. B. Dean*, A. T. Adesogan, N. Krueger, and R. C. Littell, *University of Florida, Gainesville.*

This study determined the effectiveness for improving the nutritive value and aerobic stability (AE) of bermudagrass (*Cynodon dactylon*) silage, of applying four proprietary cellulase/hemicellulase enzymes. A five-week regrowth of Tifton 85 bermudagrass was conserved alone, or after treatment with Promote (Pr), Biocellulase X-20 (X20), Cattle-Ase (CA) or Biocellulase A-20 (A20). The enzymes were applied at 0, 0.5, 1x and 2x the rates recommended by the manufacturers. Six replicates of 1 kg of chopped (5 cm) forage were ensiled for 145 days in 2.8 l mini silos. Three silos per treatment were used for chemical analysis and three to measure aerobic stability (4 x 3 factorial design). The silage juice was analyzed for organic acids, pH, water soluble carbohydrates (WSC), ammonia-N and soluble N. Freeze-dried samples were analyzed for crude protein (CP), NDF and ADF. In vitro digestibility of DM (IVDMD), NDF (IVNDFD) and ADF (IVADFD) were calculated after digesting the silages in buffered rumen fluid for 6 or 48 h in two ANKOMII Daisy Incubators. The following results are based on comparing treated to untreated samples. DM losses and pH were significantly reduced by Pr ($P < 0.01$). Ammonia-N was increased linearly ($P < 0.05$) by X20, but decreased linearly and quadratically by CA ($P < 0.05$) and A20 ($P < 0.05$) respectively. Residual WSC concentration was increased by Pr ($P < 0.01$) and CA ($P < 0.05$). NDF and ADF concentration were reduced ($P < 0.05$) by X20, CA and A20. Additive-treated silages had less ($P < 0.05$) acetic acid than untreated silages, but aerobic stability was unaffected by treatment. The 6 h, IVDMD was increased ($P < 0.01$) by Pr and A20, however only Pr increased ($P < 0.01$) 48 h IVDMD and 48 h IVNDFD. Pr ($P < 0.05$), CA ($P < 0.05$) and A20 ($P < 0.05$) also increased ($P < 0.05$) 48 h IVADFD. These results show that fibrolytic enzymes can improve the nutritive value of bermudagrass silage, and Promote was the most promising enzyme in this respect.

Key Words: Enzymes, Silage, Nutritive Value

616 Development and use of an assay to test enzymatic activity of rumen microflora in calves. B. J. Suarez*, S. Fiardo, A. H. M. Cornelissen, P. Van Wikselaar, and W. J. J. Gerrits, *Wageningen University Unit Research, Wageningen, The Netherlands.*

The objective of this study was to develop an assay to quantify cellulase activity in rumen contents of calves fed different diets. Eighteen male calves (45 ± 0.2 kg) were individually housed and fed diets differing in carbohydrate composition: a Pectin rich diet (> 90% Sugar beet pulp), a NDF rich diet (> 90% soy hulls + maize bran), a Starch rich diet (> 90% barley + maize). Diets were offered to a maximum of 750 g/d on top of a milk replacer. Calves were slaughtered at 12 weeks of age and rumen samples were stored (-20°C). Intra and extra-cellular enzymes and enzymes attached to rumen particles were extracted by a combination of methods: freezing/thawing, sonication and osmotic shock. After thawing, samples were sonified in a 50 mM NaAc buffer (pH 5) including 2 M NaCl and 0.01% NaN₃. Subsequently feed particles and lysed bacteria were removed (centrifugation: 22.5 min, 20000g, 4 °C) and the

enzyme cocktail obtained was dialyzed against a 50 mM NaAc buffer (18 h; 4 °C) to remove dissolved sugars and NaCl. Enzyme activity was determined by the release of reducing sugars after incubation of the enzyme cocktail at 39 °C (120 mM NaAc buffer) with each of 3 substrates: Carboxymethylcellulose (CMC), soybean hulls (SBH) and crystalline cellulose (Avicel), and expressed as μmol reducing sugars (RS) released per minute per kg dry matter (DM) in the rumen. Reducing sugar end-groups were measured by Nelson Somogyi method. Avicel was hardly degraded by the enzyme cocktail (1 μmol of RS/h/kg DM), while CMC and SBH were well degraded (48.7 and 51.6 μmol RS/h/kg DM respectively; $P = 0.05$). CMC- and SBH-ase activities of rumen contents decreased from 61, 48.5 to 41 μmol RS/h/kg DM for calves fed the NDF, Pectin and Starch diet, respectively ($P = 0.1$). Results show that differences in enzyme activity between rumen contents can be detected using this assay. By using different substrates, the degrading capacity of others enzyme systems can be evaluated.

Key Words: Calves Rumen Contents, Microbial Enzyme Activity, Cellulase

617 Effects of feeding increasing levels of vitamin E on milk production variables, plasma fatty acid composition, and milk fatty acid profiles in Holstein cows experiencing diet induced milk fat depression. H. C. Hafliker III*, C. E. Moore, S. R. Sanders, and L. H. Baumgard, *The University of Arizona, Tucson.*

Recent research indicates feeding high levels of vitamin E (VitE) may alleviate milk fat depression (MFD) by altering rumen polyunsaturated fatty acid biohydrogenation pathways. Objectives were to evaluate the effects of extremely high VitE doses on production variables, milk, and plasma fatty acid profiles (a proxy for rumen biohydrogenation) on diet induced (4% corn oil, 45% forage) MFD. Multiparous Holstein cows (283 ± 15 DIM; 136 ± 15 d pregnant; n=6) were randomly assigned to an unbalanced 4x4 Latin square design consisting of a control (0 additional IU/d VitE) and VitE top dressed (4000, 8000, and 16000 additional IU/d). Milk and blood samples were obtained on d 1 and at the end of treatment periods (d 14). A 7-d washout period was provided between periods. Orthogonal contrasts were used to characterize linear, cubic and quadratic effects of VitE dose. As a result of the MFD diet, milk fat content was reduced ($P < 0.02$) by 18% (3.5 to 2.8%) and milk total trans C_{18:1} and CLA increased ($P < 0.01$; 29.4 vs. 62.0 mg/g and 5.4 vs. 14.4 mg/g, respectively). VitE had no effect on DMI (24 kg/d), milk yield (32 kg/d), milk protein (1.1 kg/d), milk lactose (1.6 kg/d), SNF (3.0 kg/d), and SCC (269,855) or the content of these components. There was no effect on milk fat yield, however, VitE linearly increased ($P < 0.01$) milk fat content (2.83, 2.93, 3.05, and 3.12% for 0, 4000, 8000, and 16000 IU/d, respectively). Changes in fatty acids associated with MFD including *t*-10 and *t*-11 C_{18:1} as well as *c*-9, *t*-11 and *t*-10, *c*-12 CLA did not differ in milk or plasma as a result of VitE supplementation. Although the milk fat Δ⁹-desaturase index did not differ, VitE decreased ($P < 0.05$) specific Δ⁹-desaturase product to substrate ratios (C_{14:1}/C_{14:0}, C_{18:1}/C_{18:0}, and *c*-9, *t*-11 CLA/*t*-11 C_{18:1} by 18, 13, and 13%, respectively). Although only slightly, VitE linearly increased milk fat content but this effect was not reflected in plasma or milk fatty acid changes. Milk Fat Depression, Vitamin E, CLA

Key Words: Milk Fat Depression, Vitamin E, CLA

618 Effects of dietary forage and non-fiber carbohydrate concentrations on B-vitamin intake and duodenal flow in dairy cows. E. C. Schwab*¹, C. G. Schwab*², C. L. Girard³, R. D. Shaver¹, D. E. Putnam⁴, and N. L. Whitehouse², ¹University of Wisconsin, Madison, ²University of New Hampshire, Durham, ³Dairy and Swine R&D Center, AAC, Lennoxville, QC, Canada, ⁴Balchem Encapsulates, New Hampton, NY.

Eight Holstein cows (four primiparous, four multiparous) were fitted with ruminal and duodenal cannulas to test the effects of dietary forage (F) and NFC concentrations on intake and duodenal flow of B-vitamins in lactating cattle. Cows were used in a replicated 4x4 Latin square design balanced for carryover effects with a 2x2 factorial arrangement of treatments. Each square contained two multiparous and two primiparous cows and periods were 21 d in length. Experimental diets with 35 or 60% (DM basis) forage (corn silage, alfalfa hay, grass hay) were formulated to contain either 30 or 40% NFC (DM basis). The concentrate portion of the diets was composed of varying proportions of

soybean hulls, beet pulp, corn grain, rolled barley, soybean meal, blood meal, Smartamine-M[®], vitamins, and minerals. B-vitamin intakes and flows presented below are expressed as mg/d. There was a significant F effect for all measurements except for folic acid and B₁₂ intake and pyridoxine (PYR) flow. Intakes of DM, thiamin, pyridoxamine (PAM), and pyridoxal (PAL) and flows of B₁₂ and PAM were affected by NFC. A F×NFC interaction was observed for thiamin and PYR flow. Overall, there was a greater influence of dietary F content than NFC concentration on B-vitamin intake and flow.

Item	Diets				SEM	Effect (P <) ⁵		
	3530	3540	6030	6040		F	NFC	F×NFC
DMI, kg/d	21	22	18	20	1	<0.01	0.05	NS
Thiamin intake	37	47	27	37	2	<0.01	<0.01	NS
Thiamin flow	107	101	75	90	7	<0.01	NS	0.04
Folic acid intake	13	12	12	12	1	NS	NS	NS
Folic acid flow	33	35	27	31	3	<0.01	NS	NS
B ₁₂ intake	0.4	0.3	0.3	0.3	0.02	NS	NS	0.2
B ₁₂ flow	118	84	83	63	6	<0.01	<0.01	NS
PAM intake	9	15	8	13	1	<0.01	<0.01	NS
PAM flow	57	61	47	56	4	<0.01	0.05	NS
PAL intake	28	24	17	13	1	<0.01	<0.01	NS
PAL flow	34	39	23	28	3	<0.01	NS	NS
PYR intake	31	30	35	35	2	<0.01	NS	NS
PYR flow	11	6	6	9	1	NS	NS	0.01

⁵NS=not significant (P>0.05)

Key Words: B-Vitamin, Duodenal Flow, Cow

619 Effect of feeding malic acid on performance of lactating Holstein cows. R. J. Grant^{*1}, C. S. Ballard¹, M. P. Carter¹, K. W. Cotanch¹, P. Mandevu¹, C. J. Sniffen², M. Suekawa⁵, S. A. Martin³, T. K. Miller-Webster⁴, and W. H. Hoover⁴, ¹W.H. Miner Agricultural Research Institute, Chazy, NY, ²Fencrest LLC, Holderness, NH, ³University of Georgia, Athens, ⁴West Virginia University, Morgantown, ⁵Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan.

Limitations on feeding ruminant proteins to cattle necessitate using alternative feeds to supply amino acids such as lysine, or stimulating ruminal microbial growth to increase supply of amino acids for the host animal. In continuous culture, DL-malate (50 g/d) improved microbial growth and efficiency, resulting in an increase in metabolizable protein of 426g/d. The objective of this study was to determine the effect of feeding malic acid (MA; Harcros Chemicals Inc., Kansas City, KS) at a rate of 50 g/d on the performance of mid-lactation dairy cows. Forty cows (70-276 days in milk) were blocked and assigned randomly to control or MA diets in a crossover design with two 28-d periods. Total mixed ration included corn silage, alfalfa-grass silage, alfalfa hay, ground corn, whole cottonseed, and a commercial protein supplement. Cows fed the ration containing MA had greater yield of milk (P = 0.012) and true protein (P = 0.035) compared with cows fed the control ration. There was no effect of MA on body weight, body condition score change, or total tract digestion of nutrients (P > 0.05).

	Control	MA	SE	P
Milk Yield avg ¹ , kg/d	36.8	38.3	0.4	0.012
Milk yield ² , kg/d	37.6	39.3	0.5	0.022
3.5% FCM, kg/d	39.2	40.5	0.5	0.097
Milk fat %				
kg/d	3.79	3.70	0.04	0.117
Milk true protein %	1.42	1.45	0.02	0.288
kg/d				
3.08	3.08	0.01	0.830	
1.15	1.21	0.02	0.035	
Total tract digestibility, %				
OM	68.1	67.7	0.4	0.440
CP	62.3	62.9	0.6	0.471
ADF	47.4	47.9	0.9	0.697
NDF	46.7	46.2	1.1	0.758

¹Seven day average milk yield. ²Sample day milk yield from which milk component yields are calculated.

Key Words: Malic Acid, Dairy Cows, Microbial Growth

620 Further validation of the fat sub-model in CPM-Dairy. P. J. Moate^{*}, R. C. Boston, and W. Chalupa, *School of Veterinary Medicine, University of Pennsylvania, Kennett Square.*

CPM-Dairy contains a fat sub-model (Anim. Feed Sci. Tech. 112:79) that describes dietary intake, ruminal lipolysis, ruminal biohydrogenation, ruminal denovo production and intestinal absorption of 10 major long chain fatty acids (LCFA) and total LCFA (TLCFA) in dairy cows. The previous validation of intestinal digestion (duodenum - feces) mainly involved young (250 kg) non-lactating cattle. We now report on the ability of the model to predict, in lactating dairy cows, the apparent absorption (intake - feces) of TLCFA. Data used were from 43 diverse diets in ten published feeding experiments that reported intakes and fecal output of TLCFA (g/cow/day). Additional data were with 15 diets from three experiments in which different types of LCFA supplements were infused into the abomasum. In the table, the mean and STD of the measured (X) absorbed TLCFA (g/cow/d) is tabulated and the regression (forced through the origin) between the predicted absorbed TLCFA (Y) and X is given by B (slope) *X. For both the feeding and infusion experiments, the slopes and Lins concordance correlation coefficient indicate a high degree of concordance between measured and predicted absorbed TLCFA. We conclude the fat sub-model in CPM-Dairy accurately predicts the apparent absorption of TLCFA in lactating dairy cows.

TLCFA (Y)	X (mean± STD)	B (±Std Error)	Concordance
Feeding expts.	833 ± 266	0.99 ± 0.011	0.974
Infusion expts.	757 ± 120	1.03 ± 0.016	0.923

†Lin's concordance correlation coefficient

Key Words: Cattle, Long-Chain Fatty Acids, Apparent Absorption

621 Sensitivity analysis of the 2001 Dairy NRC and CNCPS protein fractionation systems. C. Lanzas^{*}, L. O. Tedeschi, and D. G. Fox, *Cornell University, Ithaca, NY.*

Feeding diets not properly balanced for protein decreases its utilization efficiency. Sensitivity analyses of the NRC and the CNCPS protein fractionation systems were conducted to assess the influence of the uncertainty in feed inputs on the model predictions. Two lactating dairy-cow diets either with corn (CS) and alfalfa silages (diet 1) or grass hay and CS (diet 2) plus corn meal and supplements (soybean meal (SBM), canola meal (CM), whole cottonseed (WC), wet brewers (WB) and distillers (DG) grains) were used. A feed database provided by Dairy One lab was used to obtain the distributions and correlations of the variables. Monte Carlo technique was conducted in spreadsheet versions of the models. For each diet, 3 simulations were carried out. In simulation 1 (CNCPS1), CP, Soluble protein, NPN, NDICP, and ADICP were varied. In simulation 2 (CNCPS2), the inputs for protein pools (CNCPS1) and the corresponding digestion rates (kd) were varied. In simulation 3 (NRC), CP, in situ A and C fractions and kd for in situ B fraction were varied. The maximal impact on MP, Lys and Met allowable milk (kg/day) is summarized below. Both models behaved similarly

when variation in kd was taken into account. For the NRC model, the ranking of critical inputs was, for diet 1, SBM kd ($r=-0.5$), CS A fraction ($r=-0.34$), and dried corn kd ($r=-0.25$), for diet 2, SBM kd ($r=-0.55$), grass hay CP ($r=0.32$), and dried corn kd ($r=-0.31$). For the CNCPS, the ranking was, for diet 1, SBM kd of B2 pool ($r=-0.5$), dried corn kd ($r=-0.26$), and WB CP ($r=0.26$), for diet 2, SBM kd ($r=-0.52$), grass hay CP ($r=0.36$), and dried corn kd ($r=-0.35$). One SD increase (1.5 %/h) in SBM kd resulted in a 0.5 SD decrease in MP from RUP (Diet 1 SD=153 g, Diet 2 SD=208 g), while for the CNCPS model, 1 SD increase (4 %/h) in kd for SBM B2 kd resulted in a > 0.5 SD decrease (Diet 1 SD=136 g, Diet 2 SD=177 g). Because of the intrinsic variation in kd measurements and the sensitivity of the current models, research is needed to improve the methodology used to obtain kd.

	Diet 1			Diet 2		
	CNCPS1	CNCPS2	NRC	CNCPS1	CNCPS2	NRC
MP milk from RUP	1.9	2.8	3.1	2.2	3.6	4.2
MP milk from Met in RUP	2.2	2.9	1.8	2.3	3.0	4.2
MP milk from Lys in RUP	1.4	2.2	2.4	1.3	2.6	2.7

Key Words: Nutritional Models, Monte Carlo, Digestion Rates

Ruminant Nutrition: Dairy - Fats

622 Effect of rumen protected conjugated linoleic acid on energy metabolism of dairy cows during early to mid-lactation. K. J. Shingfield^{*1}, D. E. Beever¹, C. K. Reynolds¹, S. K. Gulati^{2,3}, D. J. Humphries¹, B. Lupoli¹, G. Hervas¹, and M. J. Grinari⁴, ¹Centre for Dairy Research, University of Reading, Reading, UK, ²University of Sydney, Sydney, Australia, ³Rumentek Pty Limited, Australia, ⁴University of Helsinki, Helsinki, Finland.

Trans-10, cis-12 conjugated linoleic acid (CLA) inhibits milk fat synthesis and reduces milk energy content. Controlled decreases in milk energy secretion could be used to improve energy balance of the dairy cow during early lactation. Twelve multi-parous Holstein-British Friesian cows were used in a randomized block study to evaluate the effects of rumen protected CLA (RCLA) on energy metabolism in early lactation. Supplements were prepared by casein-formaldehyde treatment of CLA methyl esters containing equal amounts of cis-9, trans-11 and trans-10, cis-12. At calving, cows were paired and allocated at random to a control diet (C) or the same diet supplemented with 110 g of RCLA that supplied 14.3 g trans-10, cis-12 CLA/d. Energy balance (MJ/d) was estimated during weeks 3, 7, 11 and 15 of lactation using 6d excreta collection and respiration calorimetry. On average, RCLA reduced milk fat content (34.9 vs. 19.2 g/kg; $P<0.001$) and milk fat yield (1395 vs. 901 g/d; $P<0.001$), increased ($P<0.05$) milk yield (40.3 vs. 47.4 kg/d) and milk protein output (1.25 vs. 1.42 kg/d) and tended to increase DMI (22.2 vs. 24.6 kg/d; $P=0.06$) and BW (614 vs. 661 kg; $P=0.11$). The effects on DMI and production occurred within one week of lactation. RCLA increased ($P=0.08$) energy intake (389 vs. 434, for C vs. RCLA, respectively), but had no effect ($P>0.10$) on estimated heat energy (155 vs. 169), milk energy (112 vs. 103) or energy excreted in methane (25.0 vs. 26.0), urine (11.1 vs. 11.0) or feces (108 vs. 119). However, RCLA improved ($P<0.05$) tissue energy balance (-17.1, 8.5, 6.6 and 24.4 at weeks 3, 7, 11 and 15 of lactation, respectively) compared with C (-53.1, -19.3, -8.2 and -6.5). In conclusion, RCLA decreased milk fat content, increased milk production and improved tissue energy balance of dairy cows during the first 15 weeks of lactation, with evidence of improved tissue N retention (19 vs. 42 g/d; $P = 0.05$). In contrast to the effects in growing mice, heat energy/BW.75 was not affected (1.26 vs. 1.30).

Key Words: Conjugated Linoleic Acid, Energy Metabolism, Dairy Cows

623 Effects of dietary CLA on production parameters and milk fatty acid variables in Holstein and Brown Swiss cows during heat stress. C. E. Moore^{*}, H. C. Haflinger III, O. B. Mendivil, R. J. Collier, and L. H. Baumgard, University of Arizona, Tucson.

Heat stressed dairy cattle are bioenergetically similar to transition cows in that dietary intake may be inadequate to support maximum milk and component synthesis. Objectives were to evaluate whether CLA induced milk fat depression (MFD) during heat stress would allow for increased milk production and component synthesis. In addition, CLA effects on production variables, MFD and milk composition were compared between Holstein and Brown Swiss cows. Multiparous cows ($n = 8$, Holstein; $n = 5$, Brown Swiss) averaging 97 ± 17 DIM were used in a crossover design during the summer (mean THI = 75.7). Treatment period lengths were 21 d with a 7 d acclimation period prior to and between periods. During acclimation periods all cows received EnerGII[®] (a supplement of palm fatty acid distillate; Bioproducts Inc., Fairlawn, OH). Dietary treatment consisted of either 250 g/d of CLA (Bioproducts Inc.) or EnerGII. The CLA supplement contained a variety of CLA

isomers (5.4% trans-8, cis-10; 6.3% cis-9, trans-11; 7.9% trans-10, cis-12; and 8.2% cis-11, trans-13 CLA). Treatment was applied 2x/d with half of the supplement top dressed at 0600 h and the remaining at 1800 h. There was no overall treatment effect on DMI (23.9 kg/d), milk yield (40.0 kg/d), SCC (305,000), protein% (2.86) or lactose% (4.52) or yield of these milk components. CLA supplementation decreased ($P < 0.01$) overall milk fat content and yield by 21 and 24%, irrespective of breed. The reduction of milk fat content and yield was greater on d 21 (28 and 37%, respectively). Energy balance was improved ($P < 0.01$) by 3.1 Mcal/d for the CLA group (-1.1 vs. 2.03 Mcal/d, respectively). Respiration rate (78 breaths/min) and skin temperature (35.4°C) were not affected by treatment. The CLA supplemented group had higher total milk fat CLA concentrations (8.3 vs. 4.8 mg/g). CLA supplementation caused MFD similarly between breeds and improved energy balance during heat stress, but had no effect on production parameters under these conditions.

Key Words: CLA, Milk Fat, Heat Stress

624 Effects of source and level of dietary lipid on in vitro production of conjugated linoleic acid and trans vaccenic acid. X. Qiu^{*1}, K. E. Griswold², G. A. Apgar¹, D. W. Murdach¹, E. D. Frantz¹, D. L. Hastings¹, and B. N. Jacobson¹, ¹Southern Illinois University, Carbondale, ²Penn State University Extension, Lancaster.

Two in vitro experiments were conducted to investigate the effects of source and level of lipid on biohydrogenation (BH) and the production of conjugated linoleic acid (CLA) and trans vaccenic acid (TVA). Exp. 1 examined the effect of partial (50%) or complete replacement of 4% yellow grease with each of the following three plant oils: soybean oil, corn oil, and sunflower oil (SUO), respectively. Based on the results of Exp 1, Exp 2 with a total of six treatments was designed to investigate the effect of four other plant oil sources, olive oil, peanut oil, canola oil, and safflower oil (SAO), as compared to yellow grease and SUO at 4% of dietary DM. Diets were composed of corn silage, alfalfa hay, soybean meal, and contained 18.4% CP and 32.4% NDF on average. The incubation periods were 0, 8, 12, or 16 h for Exp 1 and 0, 12, 18, and 24 h for Exp. 2. Three samples were incubated per treatment per time point. Fatty acid data were analyzed using the MIXED procedure of SAS with repeated measures. Rate of BH was estimated by linear regression. In Exp. 1, source of lipid did not affect the production of TVA but affected ($P < 0.05$) the production of CLA isomers and total CLA, with SUO producing the largest increase in TVA and CLA yields; elevated level of plant oil increased the production of TVA ($P < 0.05$), total CLA ($P < 0.01$) and CLA isomers ($P < 0.01$). In Exp. 2, SUO and SAO were similarly effective ($P < 0.01$) in increasing TVA production compared to other plant oils. However, SAO was more effective ($P < 0.01$) than SUO in increasing CLA production and SUO ($P < 0.01$) was more effective than the other oils. In addition, combined information from both experiments showed that, within the range of 4% of dietary DM, rate of BH was not affected by lipid source but slightly increased as oil level increased; production of CLA peaked between 12 and 18 h, whereas the peak for TVA occurred later, around 24 h.

Key Words: Conjugated Linoleic Acid, Vaccenic Acid, In Vitro

625 Concentration of cis-12 C18:1 in milk is more closely related to milk fat depression (MFD) than trans-10 C18:1 in cows fed fish oil. M. A. S. Gama¹, J. M. Grinari², P. C. Garnsworthy³, P. H. M. Rodrigues⁴, P. R. Leme⁴, L. W. O. Souza⁴, and D. P. D. Lanna^{*1}, ¹Esalq-USP, Piracicaba, Brazil, ²University of Helsinki, Finland, ³University of Nottingham, UK, ⁴Campus Pirassununga-USP, Brazil.

Diets producing MFD alter pathways of rumen biohydrogenation, resulting in formation of intermediates which inhibit milk fat synthesis. Increased trans-10 C18:1 formation is a consistent observation. Furthermore, trans-10 C18:1 is often associated with formation of trans-10, cis-12 CLA, a precursor of trans-10 C18:1. Fish oil (FO)-induced MFD represents a notable deviation since it is associated with increased formation of trans-10 C18:1 without any increase in milk trans-10, cis-12 CLA content. This study evaluated temporal changes in secretion and fatty acid profile of milk fat in response to FO and low dietary fibre. Mid-lactation Holstein cows were used. The study was conducted in three periods: 1) Baseline: all cows (n=12) received high fibre diet (HF) without FO (baseline diet, BD) for 12 d; 2) Supplementation: cows (n=4) received three treatments for 21 d: a) HF+FO, b) Low fibre diet (LF) and c) LF+FO; 3) Post-supplementation: all cows returned to BD on 12 d. NDF contents of HF and LF were 40 and 25%, respectively. Roughage was corn silage and FO was included at 1.6% of DM. Milk fat content was progressively reduced for the first two weeks of FO supplementation, after which it reached a plateau. Co-variate adjusted LS-means for milk fat yield and content were 0.74a, 0.45b and 0.44b kg/d and 3.88a, 2.83b and 2.60b% for LF, HF+FO and LF+FO, respectively (different superscripts, P<0.05). Milk trans-10, cis-12 CLA content was unchanged by dietary treatments. However, trans-10 C18:1 and cis-12 C18:1 contents increased in FO supplemented diets (P<0.05). Temporal change in milk fat content was more closely associated with cis-12 C18:1 than trans-10 C18:1. We conclude that formation of cis-12 C18:1 is characteristic of the altered rumen biohydrogenation and a putative product of linoleic acid associated with FO-induced MFD.

Key Words: Fish Oil, Conjugated Linoleic Acid, Milk Fat Depression

626 Increasing dietary starch fermentability causes milk fat depression in low-producing, but not high-producing cows. B. J. Bradford* and M. S. Allen, Michigan State University, East Lansing.

The effects of dietary starch fermentability on milk production and fatty acid profile were evaluated in a crossover study. Thirty-two multiparous Holstein cows (121 ± 48 DIM, 41 ± 9 kg 3.5% fat-corrected milk; mean ± SD) were randomly assigned to treatment sequence and were fed a diet intermediate to the treatments during an initial 21-d period. Treatments were dry ground corn grain (DG) and high moisture corn (HM) from the same field. Treatment periods were 14 d, with the final 4 d used for data and sample collection. Diets included corn silage and alfalfa haylage at a 1:1 ratio and were ~26% NDF, 16.5% CP, 32% starch, and ~3% crude fat. Treatments had no consistent effect on production of milk, FCM, or milk components. HM decreased the concentration of C18:0 (P < 0.001) and increased concentrations of trans-9 C18:1 (P < 0.001), trans-10 C18:1 (P < 0.01), and cis-9, trans-11 CLA (P < 0.01), but not trans-10, cis-12 CLA (P = 0.18) in milk fat. HM increased trans C18:1 concentrations at an increasing rate as production level decreased (quadratic regression, P < 0.001), and milk fat depression was evident in cows below approximately 40 kg/d FCM production. In contrast, production level had little influence on milk trans C18:1 concentration for DG (slope = -0.023, P = 0.03). Milk trans C18:1 concentration was negatively correlated with milk fat concentration (r = -0.75), as was trans-9 C18:1 (r = -0.60), trans-10 C18:1 (r = -0.61), and cis-9, trans-11 CLA (r = -0.61, all P < 0.001). Concentration of trans-10, cis-12 CLA was not correlated with milk fat concentration (r = -0.11, P = 0.40). Production level may influence biohydrogenation patterns and trans C18:1 production because of differences in rumen environment; rumen pH and dilution rate can alter metabolism and populations of rumen microbes. Diets with highly fermentable starch sources and without supplemental dietary PUFA can induce milk fat depression in lower-producing cows, possibly because of increased production of trans C18 fatty acids.

Key Words: Milk Fat Depression, Trans Fatty acids, Starch Fermentability

627 Effect of timing of initiation of fat supplementation on milk production, plasma hormones and metabolites, and conception rates of Holstein cows in summer. F. M. Cullens*, C. R. Staples, T. R. Bilby, F. Silvestre, J. Bartolome, A. Sozzi, L. Badinga, W. W. Thatcher, and J. D. Arthington, University of Florida, Gainesville.

Primiparous (n=22) and multiparous (n=25) Holstein cows were used in a completely randomized block design to determine the effects of timing of the initiation of fat supplementation (Megalac-R, Church and Dwight Co. Inc., Princeton, N. J.) on cow performance the first 14 wk postpartum (PP). Four treatments were as follows: 1) control (no supplemental fat source) and 2-4) Megalac-R supplementation (2% of dietary DM) beginning at 28 d prior to expected calving date, at day of parturition, or at 28 d PP. Blood samples were collected 3x weekly from calving through wk 10 PP. An Ovsynch protocol was begun between d 5 to 10 of an estrous cycle (d 62 PP) with AI occurring at d 72 PP. Orthogonal contrasts tested for treatments were 1 vs. (2+3+4), 2 vs. (3+4), and 3 vs. 4. Mean milk production was 38.1, 41.5, 36.5, and 37.1 kg/d, tending to be greater (P = 0.06) for cows fed fat starting in the prepartum compared to the PP period. Pattern of plasma progesterone concentrations accumulated from calving to 79 d PP did not differ among treatments. Of cows that ovulated to the Ovsynch protocol, cows fed fat tended (P = 0.09) to have better first service conception rates than controls (27.8 [3/11], 40.0 [4/10], 70 [7/10], and 63.6% [7/11]). Mean plasma concentration of total bilirubin through 4 wk PP was greater (P= 0.05) in cows fed fat starting prepartum compared to those starting PP (0.36 vs. 0.22 mg/dl). Plasma gamma-glutamyl transferase of cows fed fat starting prepartum increased from wk 1 to 4 PP (25.5 to 41.6 U/L) compared to controls (25.2 to 30.2 U/L) and those fed fat starting at calving (30.4 to 25.4 U/L) (treatment by wk interaction, P = 0.01). Cows fed fat had lower mean concentrations of plasma fibrinogen compared to controls (97.7 vs. 123.0 mg/dl) the first 4 wk PP. Plasma concentrations of BHBA, albumin, alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, and ceruloplasmin were not affected by treatments.

Key Words: Fat, Milk Production, Reproduction

628 Kinetic model of rumen biohydrogenation: effects of rumen-protected fatty acid saturation on fractional rate of biohydrogenation and duodenal fatty acid flow in lactating dairy cows. K. J. Harvatine* and M. S. Allen, Michigan State University, East Lansing.

A simple model of rumen fatty acid (FA) metabolism is proposed that allows calculation of first order fractional rate of FA biohydrogenation and FA passage after determination of ruminal FA pool size and duodenal flux. Saturated and unsaturated rumen-protected fatty acid sources were evaluated for effects on fractional rate and extent of rumen biohydrogenation and duodenal FA flow. Eight ruminally and duodenally cannulated multiparous Holstein cows (77 ± 12 DIM, mean ± SD) were used in a replicated 4x4 Latin square design with 21 d periods. Treatments were control and a linear titration of 2.5% added rumen-protected FA varying in saturation: saturated (SAT; prilled hydrogenated free FA, Energy Booster 100[®]), intermediate mix of SAT and unsaturated (UNS; calcium soaps of long-chain FA, Megalac-R[®]), and UNS FA. Experimental diets were 40% forage and contained 27.5% NDF, 30% starch, and 2.5% rumen available vegetable oil (13.5% cottonseed). Rumen-protected FA increased rumen FA turnover rate. Passage rates of C16:0, C18:0 and total C18 were linearly decreased with increasing UNS and trans-C18:1 fractional passage rate was quadratically affected with a maximum for the intermediate treatment. Increasing UNS increased extent of C18:2 and C18:3 biohydrogenation and decreased extent of 18:1 and trans-18:1 biohydrogenation, resulting in increased duodenal flow of trans-C18:1. Calcium salts failed to protect polyunsaturated FA from rumen biohydrogenation despite a mean ruminal pH of 6.0. This model allows a mechanistic description of rumen biohydrogenation and determination of extent of C18:1 biohydrogenation.

Key Words: Biohydrogenation, Kinetic, Fatty Acid

629 Effect of rumen-protected fatty acid saturation on feed intake and feeding and chewing behavior of lactating dairy cows. K. J. Harvatin* and M. S. Allen, *Michigan State University, East Lansing.*

Saturated and unsaturated rumen-protected fat sources were evaluated for effects on feed intake, meal patterns and chewing behavior. Eight ruminally and duodenally cannulated cows (77 ± 12 DIM, mean \pm SD) were used in a replicated 4x4 Latin square design with 21 d periods. Treatments were control and a linear titration of 2.5% added rumen-protected fatty acids (RPF) varying in unsaturation: saturated (SAT; prilled hydrogenated free FA, Energy Booster 100[®]), 50:50 ratio of SAT and unsaturated (UNS; calcium soaps of long-chain FA, Megalac-R[®]), and UNS. Experimental diets were 40% forage and contained 27.5% NDF, 30% starch, and 2.5% rumen available vegetable oil (13.5% cottonseed). Dry matter intake for SAT was not different from control while UNS linearly decreased DMI 3.2 kg. Wet weight of ruminal digesta decreased linearly up to 11.3 kg (13 %) with increasing UNS. Adding RPF did not change meal number, meal length or time between meals compared to control, but increasing UNS decreased meal size 0.22 kg (9 %) within RPF. SAT increased time spent ruminating 56 (10 %) and 42 (7 %) minutes/d compared to CON and UNS respectively. Increasing SAT did not change rumination bout frequency or interval between bouts, but increased rumination bout length 5.6 min compared to UNS. Water intake was not affected by treatment, but increasing SAT linearly decreased the number of drinking bouts per day up to 2.9 (23 %) bouts. Increased unsaturated FA flow to the duodenum decreased feed intake by decreasing meal size, and increased saturated FA flow to the duodenum increased rumination time per day by increasing rumination bout length.

Key Words: Rumination, Feeding Behavior, Fatty Acid

630 Abomasal infusion of L-carnitine alters hepatic fatty acid metabolism and decreases liver lipid in lactating Holstein cows. D. B. Carlson*¹, H. M. Dann¹, N. B. Litherland¹, J. C. Woodworth², and J. K. Drackley¹, ¹*University of Illinois, Urbana,* ²*Lonza, Inc., Fair Lawn, NJ.*

Eight lactating, multiparous Holstein cows with ruminal cannulas were blocked by DIM (block 1, 162 ± 20 DIM; block 2, 101 ± 16 DIM) in a replicated 4 x 4 Latin square design. A 2 x 2 factorial arrangement of treatments was used to determine the effect of abomasal infusion of L-carnitine (20 g/d). During each 14-d period, treatments consisted of: 1) water infusion, ad libitum DMI (WA), 2) water infusion, restricted DMI (WR), 3) carnitine infusion, ad libitum DMI (CA), and 4) carnitine infusion, restricted DMI (CR). All cows received water infusion (1.2 L/d) on d 1-4 and either water or carnitine infusion on d 5-14. Infusions occurred at 0600, 1200, 1800, and 2400 h. Feed restriction (50% of previous 5-d DMI) was implemented on d 10. Cows were fed a TMR (16.6% CP, 1.68 Mcal/kg NE_L), and bST was injected on d 6 of each 14-d period. Liver was biopsied on d 14 of each period. Liver slices were incubated with [1-14C] palmitate (PALM) to determine conversion to CO₂, acid-soluble products (ASP), and esterified products (EP). Abomasal infusion of carnitine tended to increase conversion of PALM to CO₂ ($P = 0.06$) and increased conversion to ASP ($P < 0.01$) regardless of DMI. As a percent of total PALM metabolism, carnitine increased conversion to CO₂ ($P = 0.05$) and ASP ($P < 0.01$), while decreasing EP ($P < 0.01$). Total liver lipid content (% wet tissue) was greater (infusion x DMI; $P = 0.05$) for WR (5.14%) than for WA (4.33%), CA (4.43%), or CR (4.42%). Carnitine infusion reduced ($P = 0.04$) liver triglyceride (TG) concentration (0.30 %) compared with cows infused with water (0.65%). Infusion of carnitine increased ($P < 0.01$) free carnitine as well as long- and short-chain carnitine esters in liver tissue. Supplemental carnitine supplied posttruminally increased oxidation of PALM by liver slices in vitro and decreased hepatic concentration of total lipid and TG in vivo, which may be of particular benefit to periparturient dairy cows.

Key Words: L-carnitine, Liver, Fatty Acid Metabolism

631 Abomasal infusion of L-carnitine affects metabolic and production responses to feed restriction in lactating Holstein cows. D. B. Carlson*¹, H. M. Dann¹, N. B. Litherland¹, J. C. Woodworth², and J. K. Drackley¹, ¹*University of Illinois, Urbana,* ²*Lonza, Inc., Fair Lawn, NJ.*

A 2 x 2 factorial arrangement of treatments was used to determine the effect of abomasal infusion of L-carnitine (20 g/d) during negative energy balance. Eight lactating, multiparous Holstein cows with ruminal cannulas were blocked by DIM (block 1, 162 ± 20 DIM; block 2, 101 ± 16 DIM) in a replicated 4 x 4 Latin square design. During each 14-d period, treatments consisted of: 1) water infusion, ad libitum DMI (WA), 2) water infusion, restricted DMI (WR), 3) carnitine infusion, ad libitum DMI (CA), and 4) carnitine infusion, restricted DMI (CR). All cows received water infusion (1.2 L/d) during d 1-4 and either water or carnitine infusion during d 5-14. Infusions occurred at 0600, 1200, 1800, and 2400 h. Feed restriction (50% of previous 5-d DMI) began on d 10. Cows were fed a TMR (16.6% CP, 1.68 Mcal/kg NE_L), and bST was injected on d 6 of each 14-d period. Milk was sampled on d 7, 8, and 9 and d 12, 13, and 14. Blood was drawn at 0, 3, and 6 h relative to feeding on d 4, 8, and 12. Carnitine did not affect milk yield or milk composition prior to d 10, except for tending to decrease ($P = 0.08$) milk protein content. Restricted DMI decreased milk yield, milk fat yield, and milk protein content and yield compared with ad libitum DMI ($P < 0.01$). During feed restriction, CR (30.0 kg/d) tended to maintain 3.5% FCM (infusion x DMI; $P = 0.07$) relative to WR (27.6 kg/d). Feed restriction increased plasma NEFA (DMI x d; $P < 0.01$), while CR decreased NEFA compared to WR (infusion x DMI x d x h; $P < 0.01$). Serum BHBA was higher for CR than WR, but similar between CR and CA (infusion x DMI x d; $P = 0.01$) on d 12. Serum insulin was lower on d 12 due to DMI restriction (DMI x d; $P = 0.01$). Carnitine infusion increased ($P < 0.01$) the concentration of total carnitine in plasma compared with water infusion. Carnitine supplied posttruminally improved metabolic responses to negative energy and nutrient balances induced by DMI restriction.

Key Words: L-carnitine, Metabolism, Milk Yield

632 Cholesystokinin mediates intake regulation of high fat diets in ruminants by acting on the reticulo-omasal sphincter. D. Kumar¹, M. A. Froetschel*¹, T. D. Pringle¹, and D. H. Keisler², ¹*The University of Georgia, Athens,* ²*University of Missouri, Colubia.*

Four yearling (320 kg) and four mature (650 kg) ruminally-fistulated Holstein steers were used in two, simultaneously run 4X4 Latin square designed trials to investigate the role of CCK and leptin in intake regulation of cattle fed high fat diets. Steers were fed diets containing 0, 3, 6, or 9% supplemental fat. Megalac was substituted for corn in high fat diets. All diets were formulated to contain 16.5% CP and 38.5% RUP. Diets contained concentrate and chopped Bermudagrass hay in the ratio of 2:1 and were fed once daily. Experimental periods were 10 days in length. On d 9, rumens were evacuated before feeding and again 6 h afterwards. Rumen contents were weighed, sampled and immediately replaced to provide estimates of rumen particulate disappearance rates. Reticulorumen motility was measured 1-3 h after feeding. Reticulo-omasal orifice opening time was measured only in yearling steers. Jugular blood samples were collected every 30 min, 1 h before and 3 h after feeding. Blood samples were analyzed for leptin, insulin, and glucose. On d 10, all procedures on d 9 were repeated except devazepide (70ug/kg BW), a CCK-A receptor antagonist, was injected into the jugular vein 1 h after feeding. Dietary fat decreased DMI 10.6 -13.1% (Linear, $P < .05$) in both yearling and mature steers. Yearling steers ate more as a percent of body weight as compared to mature steers (2.94 % VS 2.14%). Devazepide did not influence DMI. Dietary fat had no effect on reticulo-rumen motility, but devazepide increased motility irrespective of dietary treatment. Dietary fat decreased reticulo-omasal orifice opening time by 7.3 to 33.6% (Linear, $P < .05$) in yearling steers and this effect was blocked by devazepide. Dietary fat decreased disappearance of ruminal digesta in yearling steers and this effect was blocked by devazepide. Neither dietary fat, devazepide or steer maturity affected leptin, insulin, or glucose. This data suggests that CCK-A is involved in regulating activity of the reticulo-omasal sphincter, thereby influencing reticulo-ruminal passage and mediating intake of ruminants fed dietary fat.

Key Words: Intake, Fat, Cholecystokinin

633 Effect of feeding Ca salts of palm oil (PO) or a blend of linoleic and monoenoic trans fatty acids (LTFA) on uterine involution and reproductive performance in Holstein cows. S. O. Juchem^{*1}, R. L. A. Cerri¹, R. Bruno¹, K. N. Galvao¹, E. W. Lemos¹, M. Villasenor¹, A. C. Coscioni¹, H. M. Rutigliano¹, W. W. Thatcher², D. Luchini³, and J. E. P. Santos¹, ¹University of California Davis, ²University of Florida, Gainesville, ³Bioproducts, Inc.

Objectives were to evaluate the effects of Ca salts differing in fatty acid profile on uterine involution and reproduction of dairy cows. After blocking according to parity, BCS at dry off and previous lactation milk production, 397 Holstein cows were randomly assigned to one of the two treatments consisting of Ca salts (2% diet DM) of either PO or LTFA from 23 d prepartum to 70 DIM. Body condition of all cows was scored at -43, -23, calving, and at 40, 70, 100 and 140 DIM. Blood was sampled during the first 21d postpartum four times weekly from a subset of 60 cows and plasma was analyzed for PGF metabolite. Ultrasound evaluation was performed weekly from 14 to 42 DIM to determine uterine diameter, thickness of the uterine wall, presence of fluid and interval to first ovulation. Cows were timed inseminated following the Ovsynch protocol at 72 DIM. Continuous and binomial data were analyzed by the MIXED and LOGISTIC procedures of the SAS (2001) program. Source of fatty acids had no effect on BCS either pre- or postpartum ($P < 0.40$). Incidence of retained placenta (6.5 vs 6.7%) and interval from calving to first postpartum CL (27.9 vs 28.3 d) did not differ ($P > 0.15$) between PO and LTFA, respectively. Interval from calving to disappearance of uterine fluid was reduced in cows fed LTFA compared to PO (27.6 vs 25.8 d; $P = 0.04$). Pregnancy rate after first postpartum AI tended to be higher for LTFA than PO at 27 (36.1 vs 28.1%; $P = 0.09$) and 41 (33.5 vs 25.6%; $P = 0.09$) d after AI, but pregnancy losses were similar ($P = 0.74$) and averaged 7.9%. Ca salts differing in fatty acid profile affected reproduction of dairy cows.

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Key Words: Reproduction, Fatty Acids, Dairy Cows

634 Responses of milk fat composition to dietary non-fiber carbohydrates in Sarda dairy sheep. A. Nudda^{*}, S. Fancellu, F. Porcu, F. Boe, and A. Cannas, *Dipartimento di Scienze Zootecniche, University of Sassari, Italy.*

Diets with high concentration of non-fiber carbohydrates (NFC) often induce milk fat depression (MFD) and changes in the fatty acid (FA) composition of milk in cows. In sheep MFD is less common, even when high NFC diets are fed at very high levels of intake or when they are supplemented with unsaturated oil. However, there are very few studies on sheep milk fatty acid composition for these diets. For this reason, an experiment was carried out to study the effect of diets with high (43% of DM) and low (28% of DM) NFC concentration on fat content and FA composition in sheep milk. Ten Sarda dairy sheep in midlactation were individually fed ad libitum diets that contained 56% of finely chopped alfalfa hay and 44% concentrate. The concentrate was mainly corn and barley in the high NFC diet (H-NFC), while soybean hulls were used in the low NFC diet (L-NFC). Both diets had similar fat content but the H-NFC diet contained higher concentration of C18:1 (+28%) and C18:2 (+25%) than L-NFC diet. DMI was affected by dietary treatments (H-NFC = 2501 g/d; L-NFC = 2891 g/d; $P < 0.005$). The ewes fed the

H-NFC diet consumed more C18:1 and C18:2 and less C18:3. Milk yield was not affected by the treatments (H-NFC = 1674 g/d; L-NFC = 1765 g/d). Milk fat content (7.1% vs. 7.0%) and milk fat yield (116 vs. 122 g/d) did not differ between H-NFC and L-NFC diets. Sheep fed H-NFC diets had higher milk C6 to C12 FA and lower C18:0 and cis-C18:1 FA. All trans-C18:1 positional isomers were significantly higher for sheep fed H-NFC diet. The t10 C18:1 content was more than doubled in H-NFC ($P < 0.01$). Total trans-C18:1 acids and individual isomers did not affect milk fat content. The c9,t11 CLA isomer was significantly higher for sheep fed H-NFC. The desaturase index, calculated as c9,t11 CLA/(t11-C18:1 + c9,t11 CLA), was lower in H-NFC group ($P < 0.01$). Overall, the higher trans-C18:1 and CLA and lower C18:0 and desaturase index in milk fat of sheep fed H-NFC diets suggest that rumen biohydrogenation of unsaturated FA is slower and thus more unsaturated FA escapes from rumen. The high NFC diet used in this study did not decrease fat synthesis in sheep milk. (Research supported by MiPAF).

Key Words: Dairy Sheep, Non-Fiber Carbohydrates, Milk Fatty Acids

635 Nutritional properties and use of rumen protected oilseed /conjugated linoleic acid (CLA) supplements. S. K. Gulati^{*1}, S. W. McGregor², and T. W. Scott², ¹Sydney University, ²Rumentek Pty Ltd.

FDA (2003) has recently approved the use of formaldehyde as a feed additive for dairy and beef dietary supplements derived from oilseeds/meals. The practical significance of this is that the same diet containing rumen undegraded protein (RUP), rumen undegraded fat (RUF) and designer n-3, n-6 fatty acids can be included in the rations of lactating and non-lactating ruminants. The proportions of RUP and RUF in the supplements made by emulsification and formaldehyde treatment of soybean/canola oilseeds are approximately 90% and 80% respectively; the intestinal digestibility of the C18 unsaturated fatty acids and essential amino acids is 90% and 82%. Oilseeds supplements can be designed in terms of fat content and composition for specific production goals eg, improving reproductive performance, enhancing the physical and nutritional properties of milk and meat. In the current experiment our aim was to determine if the CLA induced suppression of milk fat could be reversed by feeding rumen protected (RP) oilseed supplements. Five Holstein cows in mid-lactation, grazing a predominantly kikuyu based pasture, were fed RP-CLA alone (61.5g/d equivalent to 10.3g/d trans10, cis12 and 10.2g/d of cis9, trans11) for 4 days followed by a combination of RP-CLA and RP-soybean/canola oilseed, the latter providing 656g of additional fat per day. RP-CLA alone reduced milk fat by 30% (from 3.4% to 2.4%; $P < 0.001$) and fat yield by 28% (from 826g/d to 594g/d; $P < 0.001$). In combination with RP-soybean/canola oilseed, milk fat increased from 2.4% to 3.4% ($P < 0.001$) and fat secretion was enhanced from 594g/d to 858g/d ($P < 0.001$). This result indicates that the mechanism of CLA induced milk fat depression occurs primarily in the lipogenic pathways within the mammary gland and not on the uptake and transfer of circulating fatty acids. From a dairy industry perspective, it is now practical to design and feed RP fat/protein supplements that produce beneficial effects on performance and product quality.

Key Words: Rumen Protected Oilseeds, CLA

Sheep Species

636 Effect of GnRH in conjunction with ram introduction on the induction of fertile estrus during the non-breeding season. K.M. Jordan^{*}, A.K. Wurst, E.K. Inskeep, and M. Knights, *Division of Animal and Veterinary Sciences, West Virginia University, Morgantown.*

Introduction of novel rams to anestrus ewes, the ram effect, can be used as a tool for out-of-season breeding but produces a variable response. A single injection of progesterone at ram introduction (RI) and treatment with PG on d 12-16 improved the proportion of pregnant ewes. Maintenance of the ram-induced corpus luteum (CL) up to PG treatment is probably crucial to success of this procedure. Therefore, the effect of a GnRH injection in conjunction with RI was evaluated in anestrus ewes. In addition, the effect of presence of a CL prior to PG injection on fertility of anestrus ewes was tested. In early July, ewes ($n = 28$ -

32/group) were exposed to intact rams for 35d and given an ovulatory dose of GnRH (100 μ g) on d2, d7 or both days following RI. The presence of a CL was determined by transrectal ultrasonography on d7 and d14 at which time an injection of 20 mg PG (Lutalyse) was given. Pregnancy was diagnosed on d52 and d67 relative to RI. Mean estrous response (56%), pregnancy rate to the first (PR1; 29%) and second (PR2; 65%) service periods did not differ among groups. Because of potential for a CL induced by RI or GnRH to be short-lived, the effect of presence of a CL on d7 and/or d14 on fertility variables was examined. Ewes were reclassified as having: no CL on d7 or 14 (CL 0; $n = 14$), a CL on d7 only (CL 7; $n = 10$), a CL on d14 only (CL 14; $n = 16$), or a CL on both days (CL 7,14; $n = 16$). More ewes ($P < 0.01$) in CL 7 (70%), CL 14 (81%) and CL 7,14 (81%) were marked by rams than in CL 0 (14%). PR1 and PR2 were greater in ewes in CL 7,14 (53 and 81%) and CL 14 (38 and 93%) than in CL 0 (7 and 38%). PR1 tended to be higher ($P = 0.06$)

in ewes in CL 7,14 than in CL 7 (30%), which did not differ from CL 0. Percentages of ewes lambing to the first and both services were 7 and 14, 30 and 50, 25 and 81, and 47 and 76 for the four groups respectively. Percentage of ewes lambing to the first service was greater ($P = 0.01$) in CL 7,14 than in CL 0 and more total ewes lambed in groups with CL than in CL 0. Although one or two injections of GnRH after RI did not improve reproductive performance of anestrus ewes, the value of presence of a CL at PG treatment was confirmed.

Key Words: GnRH, Anestrus ewe, Fertility

637 The effect of metabolizable protein and machine milking on the periparturient relaxation of immunity against *Teladorsagia circumcincta* in dairy ewes. E. C. Partington*, J. Donaldson, L. A. Sinclair, and A. M. Mackenzie, Harper Adams University College, Newport, Shropshire, UK.

Increased anthelmintic resistance has led many to investigate alternative methods of parasite control. It is believed that most larval contamination of the pasture is derived mainly from the mature breeding ewe due to the periparturient relaxation of immunity (PPRI). Increasing the metabolizable protein (MP) supply of the ewe in late pregnancy may moderate the PPRI. Previous studies by the author investigating the effect of MP supply to dairy ewes on faecal nematode egg counts (FECs) have not shown significant differences. This study investigated the effects of MP supply and machine milking on the PPRI. Thirty-two pregnant dairy ewes were fed 1 of 2 diets and allocated to 1 of 4 groups: Low MP (0.98 x daily requirement) milked, Low MP, suckled, High MP (1.75 x daily req.) milked or High MP, suckled, in a 2 x 2 factorial design (n=8), from -6 to +7 weeks around parturition. From week -6 ewes were inoculated with 30,000 *Teladorsagia circumcincta* larvae/week. The lambs from the milked ewes were weaned at 72 hours old and the ewes machine milked 3 times/day (yields recorded and samples collected weekly). The remaining ewes suckled twins with milk yield estimated by lamb weight gain. The ewes were slaughtered in week +7 to determine worm burden (WB). FECs and WB were transformed according to $\text{Log}_{10}(n+1)$ prior to statistical analysis using GENSTAT. An increased MP supply lowered ($p < 0.001$) ewe FECs *pre-partum*. During lactation suckling increased ($p = 0.009$) ewe FECs. Ewes that were suckled had higher milk yields ($p = 0.001$) and higher WB ($p = 0.002$) than the milked ewes. An increased MP supply increased ($p < 0.001$) ewe weight gain up to parturition, while during lactation ewes that suckled lost more weight ($p = 0.003$) than the milking ewes. Conclusion increased MP supply reduced the PPRI in the dairy ewes, however it may not be advised to use solely machine milked animals to study the effects of the PPRI. More work on how increased MP supply lowers FECs is needed.

Key Words: Periparturient, Sheep, Nematodes

638 The effect of iodine supplementation to ewes in late pregnancy on lamb serum immunoglobulin level. T. M. Boland*, M. J. Guinan, M. A. Foley, P. J. Quinn, J. J. Callan, and T. F. Crosby, University College Dublin, Dublin, Ireland.

High levels of iodine, fed as part of a mineral premix, negatively impact on lamb serum immunoglobulin G (IgG) levels at 24h post partum. The objective of this study was to examine if this high level of iodine, when offered independently of other minerals, elicits a similar effect. Forty-four ewes of mixed breeds were used to examine the effect of dietary iodine supplementation in late pregnancy on lamb serum IgG values. The ewes were individually penned and offered grass silage ad-libitum, supplemented with 500g of 19% crude protein (CP) concentrate from day 105 of pregnancy. Ewes were allocated to one of four treatments: T1, control (C) no mineral supplement; T2, supplemented with Ca, P, Mg, Na, Mn, Co, I, Zn, Se and Vit. E (M); T3, as T2 but excluding iodine (-I); T4, supplementary iodine only (IO). Colostrum yield was measured following hand milking at 1, 10 and 18h after parturition. A blood sample was taken from the lambs at 24h post partum for IgG determination. IO ewes had higher DM and CP intakes than C or M ewes ($P < 0.05$). Treatment did not affect gestation length, lamb birth weight, colostrum yield at 1, 10 or 18h or total colostrum yield to 18h post partum. While lambs from the M treatment were fed more colostrum than the C lambs ($P = 0.02$) there was no difference when colostrum intake was expressed per kg lamb birth weight ($P > 0.05$). Treatment had a significant effect on lamb serum IgG level at 24h post partum ($P < 0.001$). Lambs from the -I treatment had the highest IgG level (19.2g/l) and this was higher than in the control (15.1g/l; $P = 0.02$), the M (1.5g/l;

$P < 0.001$) and the IO treatments (1.1g/l; $P < 0.001$). Lamb serum IgG values were higher in C than in the M and IO treatments ($P < 0.001$). We conclude that at the supplementation level applied in the current study that iodine offered on its own or as part of a mineral pre-mix, will equally and significantly lower the lamb's ability to absorb IgG from the colostrum.

Key Words: Iodine, Sheep, IgG

639 The effects of mineral block intake by ewes in late pregnancy on dietary intake and IgG absorption by the progeny. T. M. Boland*, D. Joyce, P. J. Quinn, J. J. Callan, and T. F. Crosby, University College Dublin, Dublin, Ireland.

Molassed mineral blocks are a free choice form of mineral supplementation that minimize both labor in the feeding of minerals and the disruption caused at feeding time. However, relatively little information is available on the intake of these blocks. Target intake guidelines in the range 20-30g/hd/day are commonly quoted. In an attempt to quantify the intake of mineral blocks when offered ad libitum in the last month of gestation, 158 ewes (114 single bearing (SB) and 18 twin bearing (TB)) were group housed, in addition to 26 individually housed TB ewes) were assigned to this study. Block intake was recorded daily in all treatments while food and water intake, colostrum yield, composition and the intake of colostrum by each lamb was measured at 1, 10 and 18h after parturition for the individually fed animals. A blood sample was taken from the progeny of the individually fed ewes at 24h post partum for IgG determination. Daily block intakes for the single bearing, twin bearing group fed and twin bearing individually fed ewes were 73g (range 40-95g), 117g (range 77-138g) and 206g (range 175-223g) per hd/day respectively. These intakes represent a 3-10 fold increase on commonly quoted guidelines. There was no effect of treatment on voluntary food intake. The daily water consumption (l/ewe/d) was higher when the ewes had access to mineral blocks (2.24 vs 0.77; $P < 0.05$). Treatment had no effect on colostrum yield, IgG concentration of the colostrum or total colostrum IgG yield. Although the intake of IgG to 18h was similar for lambs in both treatments (30.0 vs 30.5 g/lamb) the percentage of colostrum IgG absorbed was significantly lower when the ewes had access to mineral blocks (26.1 vs 6.5; $P < 0.05$). We conclude that the provision of ad libitum access to this mineral block to ewes in late pregnancy resulted in intakes that were both variable and excessively high, resulting in increased water intake and a reduction in lamb serum IgG values.

Key Words: Mineral, Sheep, IgG

640 Shear force and sensory attributes of lamb from hair sheep composite breeds. S. P. Greiner¹, D. R. Notter¹, and S. K. Duckett^{*2}, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²University of Georgia, Athens.

One hundred fifty seven lambs from two locations (L1, L2) were evaluated over a three yr period to assess the effect of breed type on shear force and sensory panel attributes. Dorper (DP) and Dorset (DO) cross-breeds (out of $\frac{1}{2}$ -DO, -Rambouillet, -Finnsheep ewes) were produced in all three yr at L1, along with straightbred Katahdin (KT) and Barbados Blackbelly x St. Croix (HH) wethers in 2001 and 2002. At L2, DP and Suffolk (SU)-sired lambs (out of SU dams) were produced in 2001 and 2002. Lambs were weaned at 90 d of age, grazed, and then fed a high-concentrate diet prior to harvest at 8 mo of age. Loins from carcasses were aged at 4° C for 10 d and frozen at -20° C for subsequent Warner-Bratzler shear force (WBS) and sensory analysis. Two 2.54 cm chops from each loin were broiled to an internal temperature of 71° C, and rated by a trained sensory panel for overall tenderness (T), juiciness (J), lamb flavor (LF), and off-flavor (OF) using a 8-point scale (1 = extremely tough, dry, and bland; 8 = extremely tender, juicy, and intense). A model that fit year, location and breed type was used to evaluate DP vs non-DP (ND; DO and SU) breed types. No breed by location interactions were observed. WBS values were 0.25 kg lower ($P = 0.01$) for DP than ND (2.30 vs 2.65; SEM = 0.14). Similarly, panelists tended to rate DP more T ($P = 0.06$) than ND (5.62 vs 5.27; SEM = 0.19). Scores for J, LF, and OF were similar ($P > 0.13$) between DP and ND. At L1, a model that fit breed and year was used to assess differences among breed types. WBS values were 2.81, 2.50, 2.45, and 2.44 kg for DO, DP, KT, and HH, respectively ($P = 0.10$; SEM = 0.16). Breed types rated similarly for all sensory traits. Palatability characteristics

exhibited by hair breeds of sheep may contribute positively to genotypes developed for low input, easy care production systems.

Key Words: Lamb, Tenderness, Sensory Evaluation

641 Evaluation of ultrasound measurements to predict carcass ribeye area and fat thickness in lambs. C. J. Hiemke^{*1}, D. L. Thomas¹, T. A. Taylor¹, R. G. Gottfredson¹, and S. Pinnow², ¹*University of Wisconsin, Madison*, ²*Pinn-Oak Ridge Farm, Delavan, WI*.

The objective of this study was to evaluate ultrasound measurements to predict carcass ribeye area (REA) and fat thickness (FT). Lambs were measured once with an Aloka 500 ultrasound machine with a 3.5 MHz linear probe set over the loin between the 12th and 13th ribs. Lambs were in 8 different groups (n=174, 6 to 89/group) spread over a 13 mo period. Digital ultrasound images were saved to a PC and measured with ImageTool (www.ddsdx.uthscsa.edu/dig/itdesc.html). Carcass measurements on 89 lambs were obtained using a REA grid and ruler on the carcass. Measurements on 85 lambs were obtained by tracing the cross section of the loin and the subcutaneous fat layer onto acetate paper. Carcass REA was measured with a compensating planimeter, and carcass FT was measured with a ruler from the trace. All ultrasound measurements were collected by one operator who was a novice

at the start of the study. Pearson (Spearman rank) correlations between ultrasound and carcass measurements of all lambs were .70 (.71) for REA and .77 (.75) for FT ($P < .001$). Within group correlations increased from .40 to .93 for REA and from .59 to .96 for FT from the 1st to the 8th group of lambs. Ultrasound loin width and 3 loin depths were correlated ($P < .05$) with carcass REA (n=79), however, these correlations (.25 to .58) were lower than the correlation between ultrasound REA and carcass REA (.72). Prediction equations generated using stepwise regression (n=174) were: Carcass REA, $\text{cm}^2 = 3.66 + .85(\text{ultrasound REA})$, ($R^2 = .49$) Carcass FT, $\text{cm} = .071 + .88(\text{ultrasound FT})$, ($R^2 = .60$) Carcass FT, $\text{cm} = -.203 + .82(\text{ultrasound FT}) + .01(\text{carcass wt, kg})$, ($R^2 = .62$). Experience of the ultrasound operator is important. Using all data collected during the study while the operator was gaining experience, approx. 50 and 60% of the variation in carcass REA and FT was accounted for by ultrasound REA and FT, respectively. However, in the last two groups, variation in carcass REA and FT accounted for by ultrasound was approx. 80 and 75%, respectively.

Key Words: Lamb, Ultrasound

ABSTRACTS
Wednesday, July 28, 2004

POSTER PRESENTATIONS

* Author Presenting Paper

PSA - Nutrition II

W1 Gluconeogenesis and Krebs Cycle metabolism in 2-day-old fed and fasted chicks. N. E. Sunny*, S. W. El-Kadi, M. Oba, S. L. Owens, R. Angel, and B. J. Bequette, *University of Maryland, College Park.*

Neonatal chicks rapidly adapt their metabolism from the nutrient environment in ovo to exogenous feed at hatch. Our aim was to profile evolution of metabolism and gluconeogenesis by 2-d-old chicks (45 g), and to determine the influence of a 48-h starvation on this metabolism. Broiler hatchlings were assigned to Fed (n=5) or Starved (n=7) groups. Fed (1.5 g/d) chicks were given by gavage (3×/d) a solution (1.5 ml) containing 65% dextrose (43% as [U-¹³C]glucose), 24% casein, 3% soy oil and a mineral-vitamin mix. Starved chicks were dosed (1.5 ml, 3×/d) with water containing [U-¹³C]glucose (50 mg/dose). After 48 h, chicks were killed and plasma collected. Gluconeogenesis and Krebs cycle metabolism were determined from ¹³C-mass isotopomer distribution analysis and isotope dilution of plasma glucose, aspartate (oxaloacetate, OAA) and glutamate (α-ketoglutarate, α-KG), and liver free alanine (3-carbon pool). Rates of gluconeogenesis plus glycogenolysis (112 g glucose/kg BW/d) did not differ, but these accounted for less (P<0.0001) of total glucose entry in Fed than in Starved chicks (82 vs. 96%). Irrespective of feeding regime, glucose carbon recycling accounted for 80% of gluconeogenesis. Glucose metabolized by the Krebs cycle was similar for Fed and Fasted chicks with 26% of acetyl CoA and 6% of OAA flux derived from glucose. Thus, >70% of Krebs metabolism via acetyl-CoA and maintenance of anaplerotic reactions at OAA and α-KG required catabolism of amino acids and lipids. A greater (P<0.001) proportion of glutamate synthesis derived from glucose in Fed (41%) than in Starved (23%) chicks. Proline synthesis from glutamate was 16% for Fed and 22% for Starved chicks. For Fed chicks, the balance (84%) must derive from dietary proline. These data suggest that glucose is not the major substrate for energy metabolism in neonatal chicks. Thus, new criteria may be needed to define protein quality for neonatal chicks that considers requirements for protein synthesis and for energy metabolism.

Key Words: Poultry, Amino Acids, Gluconeogenesis

W2 Effect of decreasing levels of protein in the diet on growth performance of Japanese quail fed fattening diets. R. Barajas*, J. J. Lomeli, J. F. Obregon, and J. J. Portillo, *FMVZ - Universidad Autonoma de Sinaloa, Carr. Culiacan - Mazatlan.*

With the objective of determine the effect of decreasing levels of protein in the diet on growth performance of Japanese quail fed fattening diets, a four week feeding experiment was performed. Six hundred Japanese quail one day old were used. They were randomly divided in 12 groups of 50 animals; each group was placed in elevated metal wire cages (0.9 x 0.9 x 0.5 m). In agreement with a complete randomized experiment design, three feeding programs treatments were assigned: 1) Diet with 24 % of CP (2.92 Mcal ME/kg) during the four weeks (Control); 2) Diet with 24 % CP during the first two weeks, and with 21% CP the last two weeks; and 3) Diet with 28 % CP in the first week, 24 % CP in the second, and with 21 % CP the last two weeks. Food and fresh clean drinking water were free access available. Crude protein levels effect were compared by orthogonal contrasts. Ending body weight (198 ± 2.1 g) was not affected (#8805 0.35) by treatments. In week 3 average weekly weight gain was lower (P= 0.03) with 21 % CP than 24 % CP. Body weight gain of experiment (179.5 ± 3.74 g) was not modified (P= 0.24) by treatments. Food intake was not altered (P= 0.08) by feeding programs. Feed efficiency (gain/feed ratio) during first week was better (P=0.03) with 28 % CP diets than 24 % CP diets (0.748 vs. 0.799 g gain/g food). Feed efficiency of experiment (0.395 ± 0.01 g/g) was similar (P= 0.94) for all treatments. Carcass weight was not affected (P=0.56) by treatments (119.3 ± 2.57 g). Carcass dressing was equal (P= 0.10) across treatments (59.7 ± 0.58 %). These results suggest, that is possible feeding Japanese quail during the last two weeks of fattening period with diets containing 21 % of crude protein without demerits of its growth performance response.

Key Words: Growth Performance, Protein Level, Coturnix Coturnix Japonica

W3 2-Hydroxy-4-(methylthio) butanoic acid (HMTBA) and DL-methionine yield equal growth and carcass performance under Thailand tropical conditions. S. Attamangkune*¹ and S. Chamrusspollert*², ¹*Poultry Research and Development Center, Kasetsart University, Thailand*, ²*Novus International Co.,Ltd, Thailand*.

Two trials compared the performance and carcass quality of broilers fed HMTBA (Alimet(r) feed supplement, Novus International, Inc.) or DLM (dry 99%) as methionine (M) sources in corn-SBM diets. Tropical conditions predominated in both studies with average temperature and relative humidity values of 31 °C and 70%, respectively. In Trial 1, d-old, male and female Ross x Ross chicks were assigned to three dietary treatments consisting of 14 replications of 50 birds each. Basal diets reflected Thai commercial conditions and met the requirements of all nutrients except for total sulfur amino acids (TSAA). TSAA levels were 0.72, 0.67, and 0.62% for the starter (1-21d), grower (22-42d), and finisher (43-49d) diets, respectively. Basal diets were supplemented with HMTBA or DLM equimolar meeting TSAA requirements at 0.92, 0.85, and 0.80% for the starter, grower, and finisher periods, respectively. Birds responded to M addition by improving weight gain and FCR at all times ($P < 0.05$), indicating diets were deficient in TSAA. Performance parameters were similar between M sources at all times ($P > 0.10$) however, there was a trend for higher mortality in the DLM treatments during the finisher period (1.26 vs. 0.66 and 0.18% for birds fed DLM, HMTBA and the control diets, respectively). At 49d, the body weight gain and FCR observed were 2393 and 2387g; and 2.02 and 2.02, for birds fed HMTBA and DLM, respectively. Trial 2 comprised 8 replicates of 50 birds each, fed equimolar HMTBA or DLM added at 100 or 105% of TSAA commercial levels. Weight gain and FCR improved by the addition on M sources ($P > 0.05$). No differences in performance and carcass quality were found between M sources ($P > 0.10$). To conclude, performance and carcass quality data confirm that HMTBA and DLM are equivalent as M sources when fed to broilers under tropical Thai commercial conditions.

Key Words: Tropical Conditions, 2-hydroxy-4-(methylthio) Butanoic Acid, Broilers

W4 Dietary glycine needs of broiler chicks. A. Corzo*¹, M. T. Kidd¹, D. J. Burnham², S. L. Branton³, and B. J. Kerr³, ¹*Mississippi State University, Mississippi State*, ²*Ajinomoto-Heartland*, ³*United States Department of Agriculture*.

Research delineating Gly needs for broilers is sparse. Dietary Gly might become a limiting factor in all-vegetable diets fed to broiler chicks when CP is low. A study was conducted to evaluate dietary Gly needs in broiler chicks from 7 to 20 d of age. Ross 508 male chicks were placed in 32 floor pens (15 chicks/pen; 5 pens/trt) of a closed-curtain sided house. Chicks were fed a common pre-starter corn-soybean meal based diet (3100 kcal ME/kg; 23.1% CP; 1.32% Lys) from 1 to 7 d of age, and then fed a titration diet that contained progressive amounts of 0.12% dietary Gly ranging from 0.62% (1.40% Gly+Ser) to 1.22% (2.00% Gly+Ser) from 7 to 20 d of age. Experimental diets were accomplished by supplementing Gly at the expense of a filler. Using regression analysis (95% of minimum or maximum response) it was determined that chicks optimized BW gain and feed conversion at 0.98% (1.76% Gly+Ser) and 1.02% (1.80% Gly+Ser) dietary Gly, respectively. Blood plasma free threonine and serine were unaffected by Gly supplementation, but plasma Gly linearly increased. Dietary Gly may need to be considered as a limiting nutrient in the young chick, especially if CP is low and only vegetable ingredients are used. Present results also suggest that current NRC (1994) recommendations for Gly+Ser of 1.25% may be low.

Key Words: Glycine, Threonine, Plasma amino acids

W5 Effect of chromium methionine supplementation on internal egg quality preservation in Japanese quail. F.G. Rios*, C. Angulo, G. Contreras, and J.J. Portillo, *FMVZ - Universidad Autonoma de Sinaloa (Mexico), Carr. Culiacan-Mazatlan*.

To determinate the effect of chromium methionine supplementation on internal egg quality preservation in Japanese quail, were used 680 eggs from 320 Japanese quail (240 females and 80 males), and allocated in two batteries, each battery containing with five levels, each level with 4 metal wire cages, and each cage with six females and two males. In

agreement of a complete randomised block design experiment, the animals were assigned to receive one of two treatments: 1) Diet with 21 % of CP and 2,900 kcal of ME/kg (control); and 2) Diet control but supplemented with 100 ppb of Cr from Cr-Met. 170 eggs from every treatment were collected and packed in vinyl film and stored to 4 ° C, and other 340 eggs stored to environment at 33 ° C. To 0, 3, 6, 9 and 12 d of storage time were measurement weight, dense albumin height, yolk height, width and yolk color ($L^*a^*b^*$). From this data Haugh Units and Yolk index, were calculated. Haugh Units and Yolk index were affected ($P < 0.01$) by day collection, environment preservation and storage time, but not was affected by treatment ($P > 0.10$). L^* was affected ($P < 0.01$) by environment preservation and storage time, but not was affected ($P > 0.05$) by day collection and treatment; a^* was affected ($P < 0.01$) by collection and environment preservation, but not by storage time and treatment ($P > 0.05$); b^* was affected ($P < 0.01$) by day collection, environment preservation and storage time, but not treatment ($P > 0.05$). It is concluded, than supplementation of 100 ppb of Cr, as source chromium methionine, not delayed damage the internal egg quality in Japanese quail.

Key Words: Chromium, Egg Quality, Coturnix Coturnix Japonica

W6 Breeder hen and broiler dietary carnitine: Carry-over and dietary effects on progeny growth and carcass traits. M. T. Kidd*¹, C. D. McDaniel¹, E. D. Peebles¹, S. J. Barber¹, A. Corzo¹, S. L. Branton², and J. C. Woodworth³, ¹*Mississippi State University, Mississippi State*, ²*United States Department of Agriculture*, ³*Lonza Inc*.

L-carnitine is involved in energy metabolism and membrane function: specifically that of long-chain fatty acid transfer into mitochondria and subsequent oxidation. Although Lys and Met are its precursors for in vivo synthesis, its content in grains, of which constitute a large portion of poultry diets, is thought to be limited. Ross 308 breeder hens were fed (beginning at 21 wk) test diets (0 or 25 mg L-carnitine/kg of diet), and progeny (via insemination with Ross males) were evaluated at 30, 35, and 37 wk of age representing Experiments (Exp)1, 2, and 3, respectively. Breeder pen was progeny experimental unit. All progeny were feather sexed at hatch. In Exp 1, chicks were placed in batteries (d 1 to 35) and treatments (16 replications with two subplots each) consisted of hen diet and progeny gender. In Exp 2, chicks were placed in floor pens (d 1 to 42) and treatments (16 replications with four subplots each) consisted of hen diet, progeny gender, and progeny diet (0 or 50 mg L-carnitine/kg of diet). In Exp 3, chicks were placed in floor pens equally by gender (d 1 to 42) and treatments (16 replications with two subplots each) consisted of hen diet and progeny diets (high or low nutrient density). Live performance and carcass traits were measured. Females had less ($P < 0.05$) BW gain and breast meat, but more ($P < 0.05$) abdominal fat and breast yield than males in Exp 1 and 2. Hen diet did not affect live performance, but hens supplemented with L-carnitine had progeny with reduced ($P < 0.05$) abdominal fat in Exp 3. Increasing nutrient density increased ($P < 0.05$) BW gain and carcass weights in Exp 3. Dietary L-carnitine (hen and progeny) increased ($P < 0.05$) male mortality. Additional interactive results indicated that L-carnitine in the hen diet decreased ($P = 0.07$) carcass fat and increased ($P = 0.10$) breast meat in the presence of high nutrient density. In conclusion, dietary hen L-carnitine impacted carcass traits of progeny.

Key Words: Broiler Breeder, L-Carnitine, Progeny

W7 Methionine, cystine, phenylalanine, tyrosine, and non-essential AA maintenance requirements for broiler breeders. J. M. Sun¹, M. Debeer*¹, N. K. Sakomura², and C. N. Coon¹, ¹*University of Arkansas, Fayetteville*, ²*Sao Paulo State University, Jaboticabal, Sao Paulo, Brazil*.

Two hundred and fifty 22 week old Cobb-Vantress broiler breeders were used to determine the maintenance requirement and efficiency of utilization of dietary digestible methionine, cystine, phenylalanine, tyrosine and non-essential AA in a 21 day experiment. The breeders were given crystalline amino acid diets containing graded levels of methionine, cystine, phenylalanine, or tyrosine representing 0, 10, 20, 30, 40% of their suggested requirement level (NRC, 1994) with all other amino acids maintained at 40% of their suggested requirement level. Non-essential AA maintenance requirements was determined with graded levels of glutamic acid to provide 12, 19, 26, 33, 40% of suggested CP

requirement (NRC, 1994) with all other amino acids maintained at the previously determined maintenance requirement level (Sakomura et al, 2003). The slope of methionine, cystine, phenylalanine, tyrosine, and CP accretion regression line indicated that 46% methionine, 29% cystine, 56% phenylalanine, 21% tyrosine, and 9% non-essential AA were retained. The digestible methionine, cystine, phenylalanine, tyrosine and non-essential AA requirements for zero protein accretion (maintenance) were calculated to be 101.8 mg/d, 55.3mg/kgBW.75/d or 200.2mg/kgCP/d; 30.5 mg/d, 17.0mg/kgBW.75/d or 75.4mg/kgCP/d; 229.6 mg/d, 111.7mg/kgBW.75/d or 414.4mg/kgCP/d; 65.9 mg/d, 37.2mg/kgBW.75/d or 175.6mg/kgCP/d; and 3715.2 mg/d, 2003.2mg/kgBW.75./d or 9453.0mg/kgCP/d, respectively. The net requirements of digestible methionine, cystine, phenylalanine, tyrosine and non-essential AA for protein accretion were calculated by applying a constant of specific AA in tissue protein content (10.56 mg methionine, 19.2 mg cystine, 14.28 mg phenylalanine, 24.8 mg tyrosine, 452.6 mg CP per gram of protein) and the utilization coefficient of 0.46, 0.29, 0.56, 0.21, and 0.09 resulting in the requirement of 22.96 mg of digestible methionine, 66.2 mg of digestible cystine, 25.5 mg of digestible phenylalanine, 118.1 mg of digestible tyrosine, and 5028.89 mg of digestible non-essential AA per gram of body protein accretion.

Key Words: Amino Acids, Maintenance Requirement, Broiler Breeder

W8 Comparison of methionine requirements between an alternative slow-growing genotype and a commercial genotype during the starter period. A. C. Fanatico*, P. B. Pillai, and J. L. Emmert, *University of Arkansas, Fayetteville.*

Slow-growing genotypes may be utilized in organic or natural production systems, and it is important to assess their amino acid requirements to allow more accurate and appropriate dietary formulation. Because these birds are less heavily muscled, it is theorized that their MET requirement is lower, potentially increasing their suitability for outdoor production systems where diets are not generally optimized. Further, supplemental MET is being phased out of the USDAs National Organic Program, increasing the need for understanding MET requirements. The objective of this experiment was to assess the MET requirement of slow-growing broilers, and to examine the efficacy of HMB in this alternative genotype. A MET-deficient corn-peanut meat basal diet was formulated to contain excess cysteine (CYS), and eight graded levels of DL-Met (0, 0.035, 0.070, 0.105, 0.140, 0.175, 0.210, 0.245%) were added to the basal diet and fed to two genotypes: slow-growing (S) and fast-growing (F). Each of the sixteen dietary treatments was fed to five replicate pens (containing five male chicks) from 8-21 days of age. In addition, two levels of MET (0.04, 0.08%) from HMB were fed to the S genotype. There was a linear response ($P < 0.05$) of gain and feed efficiency to incremental additions of MET below requirements. Using broken-line analysis, weight gain data revealed a digestible MET requirement of 0.30% for the S broilers, and 0.32% for the F broilers. Using slope-ratio methodology, in which weight was regressed versus supplemental MET source intake, HMB was found to be 55.2% as efficacious as DL-Met on a weight basis and 62.7% on a molar basis ($P < 0.05$), which is less than values previously observed in fast-growing commercial broilers fed a diet containing excess CYS. These data suggest that this slow-growing genotype has a MET requirement slightly below that of commercial broilers, and may use HMB less efficiently than commercial broilers.

Key Words: Organic, Methionine, Slow-Growing

W9 Effect of tap water taurine supplementation upon mortality rate by PHS; ascites, body weight and haematocrit in broiler chickens in northern Mexico. N. E. Dominguez-Avila*¹, R. Rodriguez-Martinez¹, M. Arenas-Vargas², R. Villegas-Vizcaino¹, J. H. Del Rio-Martinez¹, F. Sanchez y Garcia Figueroa², and R. Bañuelos-Valenzuela³, ¹Universidad Autonoma Agraria Antonio Narro Unidad Laguna Periferico y Carretera a Santa Fe, ²Universidad Autonoma Metropolitana Unidad Xochimilco Mexico, D.F., ³Unidad Academica de Medicina Veterinaria y Zootecnia, UAZ El Cordobel, Enrique Estrada, Zacatecas, Mexico.

Previous studies have suggested the taurine role in response to hypoxemia (low blood oxygen levels) during the pathogenesis of pulmonary hypertension syndrome (PHS; ascites), because has been proposed that cardiac taurine depletion serves to defend the heart against injury caused by regional ischemia in mammals. However, The role of taurine has not

been well documented in broilers, particularly in relation to PHS; ascites. In the present study, 500 male broiler chickens were provided tap water (control group -CON- n=250), and tap water supplemented with taurine (taurine group -TAU- 0.013% n=250) to determine the effect of taurine supplementation on tap water upon the mortality rate by PHS; ascites, body weight and haematocrit in broilers in Northern Mexico (25° NL 103° WL and 1120 masl) reared under natural conditions during the winter season. Chickens from both groups were fed according with NRC requirements and housed in two different places in the same pen. Body weight was recorded in 15, 22, 29, 36 and 41 experimental days and carcass weight and hematocrit were measured in 41 day when chicken was killed, and PHS, ascites mortality was recorded throughout the experimental period. Haematocrit, body weight were evaluated by GLM procedure and LSD test, and mortality rate by PHS ascites was evaluated by X^2 . Neither body weight nor Hematocrit were affected by treatment ($P > 0.05$) (Table 1), but we found a statistical difference ($P < 0.05$) between treatments respect to mortality rate by PHS; ascites (10.1 in CON group vs 7.2 in TAU group). These findings suggest that taurine plays an important role in the PHS; ascites prevention in broiler chickens under winter natural conditions in Northern Mexico, because the low mortality rate by PHS; ascites although we do not differences in haematocrit, one of the most reliable indicators for this syndrome. More trial to identify in a wide way the possibilities to use this amino acid in broiles chicken industry are needed.

Means of mortality rate (MR), haematocrit and body weight (BW) at 15, 22, 29, 36 and 41days in poultry chickens with tap water (CON n=250) and tap water and taruine at 0.13% (TAU n=250)

Treat-ment	MR	Haemato-crit	BW15	BW22	BW29	BW36	BW41
CON	10.1 ^a	42.0 ^a	413 ^a	792 ^a	1210 ^a	1780 ^a	2100 ^a
TAU	7.2 ^b	39.3 ^a	413 ^a	794 ^a	1220 ^a	1750 ^a	2170 ^a

^{a,b}Means within columns with different superscript differ significantly ($P < 0.05$)

Key Words: PHS; Ascites, Taurine, Broilers

W10 Broiler performance and carcass parameters of broiler fed diets containing lysine maize. M. L. Taylor*¹, B. George², Y. Hyun¹, M. A. Nemeth¹, K. Karunanandaa¹, T. T. Lohmann³, and G. F. Hartnell¹, ¹Monsanto, Co., LLC, St. Louis, MO, ²Colorado Quality Research, Inc., Wellington, ³Reussen, LLC, Bannockburn, IL.

Modern agricultural biotechnology holds great promise for meeting animal feed needs for crops that are deficient in certain essential nutrients. Two Lysine maize (LM) events called LY038 and LY049 express a lysine feedback insensitive version of dihydrodipicolinate synthase (cDHDPs) predominantly in the germ of corn kernels, resulting in accumulation of free lysine in the grain. Two 42-day broiler feeding studies using Cobb Cobb 500 male broilers were undertaken to compare the feeding value of corn hybrids containing these LM events compared to the feeding value of their respective near isogenic conventional counterparts and several conventional commercial corn hybrids. LM diets and control diets that were supplemented with crystalline lysine were formulated to have all essential nutrients except lysine above their dietary requirements so that birds would be growth responsive to changes in dietary lysine quantity and availability. Unsupplemented lysine diets were formulated to be approximately 0.08% lower in total lysine than the supplemented diets that were targeted to contain 1.06 % and 0.90% total lysine on an "as-fed" basis for the starter (0-21 days) and grower/finisher (day 21 to study end) phases, respectively. A randomized complete block design was used in the study consisting of 14 treatments that were assigned randomly to pens within 10 blocks of 14 pens each (10 males/pen). Gain, FE, and carcass yield observed with broilers fed diets containing LM were not statistically different ($P > 0.05$) from broilers fed crystalline lysine supplemented diets and were superior ($P < 0.05$) to that of broilers fed diets with conventional maize and no supplemental lysine. Therefore, the bioefficacy of the increased levels of lysine in grain from corn hybrids containing both LM events was not different from that of diets composed of conventional corn supplemented with crystalline lysine.

Key Words: Maize, Broilers, Lysine

W11 Effect of protein level and dietary germanium Biotite(Biotite V[®]) on egg production, egg quality and fecal volatile fatty acid in laying hens. W. B. Lee*¹, O. S. Kwon¹, B. J. Min¹, K. S. Son¹, J. W. Hong¹, Y. K. Han², I. H. Kim¹, and Y. K. Jung³, ¹Department of Animal Resource & Science, Dankook University, Cheonan, Korea, ²Livestock Research Institute, National Agricultural Cooperatives Federation Korea, ³Seobong BioBestech Co., Ltd, Seoul, Korea.

This study conducted to investigate the effect of dietary germanium biotite(Biotite V[®]) by protein level in laying hen diets. One hundred forty four, 51 weeks old ISA brown commercial layer, were used in experiment. Dietary treatments were 1) low protein diet(LPD), 2) high protein diet(HPD), 3) LPD-GB(LPD + 1.0% germanium biotite) and 4) HPD-GB(HPD + 1.0% germanium biotite). Hen-day egg production tended to be increased ($P < 0.01$) as the concentration of protein in diets increased. Egg weight tended to decrease by supplementation germanium biotite in the diets($P < 0.01$). Egg shell breaking strength was not influenced by germanium biotite supplementation($P > 0.05$). Large band of egg was decreased as increasing of germanium biotite supplementation in the diets($P < 0.02$). Sharp and middle band of egg were not influenced by germanium biotite supplementation. Egg yolk index tended to decrease as increasing of germanium biotite supplementation in the diets($P < 0.01$). Fecal propionic acid($P < 0.01$) and butyric acid($P < 0.03$) were decreased as the concentration of germanium biotite in the diet was increased. Also, butyric acids increased($P < 0.02$) as the concentration of protein in diets increased. Supplementation germanium biotite in the diet reduced the fecal acetic acid($P < 0.01$). Fecal NH₃-N of hens fed HPD-GB diet was decreased($P < 0.05$) compared to that of LPD-GB diet. In conclusion, germanium biotite supplementation to layer diets can be reduced fecal volatile fatty acid components.

Key Words: Germanium Biotite, Egg Quality, Laying Hens

W12 Interrelationship of threonine and glycine in growing broilers. A. Corzo*¹, M. T. Kidd¹, D. J. Burnham², S. L. Branton³, and B. J. Kerr³, ¹Mississippi State University, Mississippi State, ²Ajinomoto-Heartland, ³United States Department of Agriculture.

Threonine has the capability of partially sparing Gly in chickens. However, there is little information regarding this interconversion and the impact it has on growing broilers. A study was conducted to evaluate possible Thr and Gly interactions in growing broilers. Day-old Ross 508 male chicks were placed into 30 floor pens of a curtain sided house (14 chicks/pen). Chicks were given a common corn-soybean meal starter diet (3100 kcal ME/kg; 23.0% CP) from 0 to 21 d of age. At 21 d of age, floor pens were equalized in bird number (12 broilers/pen). Birds were fed a corn-soybean meal basal diet (3150 kcal ME/kg; 18.2% CP) with two total Gly+Ser levels (1.55 vs 1.65% of diet) and three digestible Thr levels (0.57, 0.61, and 0.65% of diet) from 21 to 42 d of age. Dietary treatments were generated by the addition of crystalline Gly or L-Thr at the expense of a filler. Two-way interactions ($P < 0.05$) were observed for BW gain where broilers fed the 1.55% Gly+Ser diet increased BW gain with Thr supplementation, while those fed 1.65% Gly+Ser were unaffected by dietary Thr. Similarly, whole carcass weight and yield increased ($P < 0.05$) with Thr supplementation when broilers were fed 1.55% Gly+Ser, but not observed when Gly+Ser was incremented to 1.65%. In parallel with previous effects, total breast meat weight responded in a similar fashion ($P < 0.05$), while its yield as well as percentage abdominal fat were unaffected by either Gly+Ser or Thr. Plasma free concentrations of Ser and Gly were increased ($P < 0.01$) as Gly was supplemented, but Thr was unaffected by Gly. As expected, plasma free Thr only increased ($P < 0.01$) with Thr supplementation. There appears to be an interrelationship between Gly+Ser and Thr, but practical implications are elusive at this point. Further research is warranted to clarify such effects.

Key Words: Glycine, Threonine, Plasma Amino Acids

W13 Dietary spray-dried plasma protein improves feed utilization, BW uniformity, and breast-meat yield of broilers raised in a relatively unsanitary environment. K. Bregendahl¹, D. Ahn¹, D. Trampel¹, J. Campbell², and J. Crenshaw*², ¹Iowa State University, Ames, ²APC.

Two identical experiments (each with 480 1-d-old Ross × Ross 308 male broiler chicks) were conducted in series to evaluate effects of spray-dried plasma (SDP) on performance. Each of 40 floor pens (1.7m², 12 chicks/pen) was assigned to a dietary treatment according to a randomized complete block design. Treatments consisted of 0.0, 0.5, 1.0, 1.5 and 2.0% dietary AP920 SDP in the starter phase (wk 1-2). The dietary SDP contents were halved in the grower phase (wk 3-4) and again in the finisher phase (wk 4-6). The corn-soy-based diets were isocaloric, met or exceeded NRC and pelleted. The dirty litter from Exp. 1 was reused in Exp. 2. The pen average daily BW gain (ADG), feed intake (FI) and feed utilization (GF) were evaluated weekly. Individual BW was recorded on d 41 and all broilers were processed on d 42 of age, after which BW uniformity (pen CV), dressing percentage (pct) and pct breast-meat were determined. Data were analyzed by ANOVA and treatment effects assessed by linear, cubic and quadratic contrasts. Mortality was lowest in Exp. 1 (5% vs. 12%), indicating a less sanitary environment in Exp. 2. SDP did not affect ADG, FI, GF or BW uniformity ($P > 0.1$) in Exp. 1, although GF decreased quadratically ($P < 0.05$) in the grower phase. SDP increased dressing pct linearly ($P < 0.05$) by 1.2 points and decreased the pct breast-meat linearly ($P < 0.05$) by 1.3 points. The decrease was attributed to person-to-person variability in the cut-up process, which was changed in Exp 2. In Exp. 2, SDP increased ADG quadratically ($P < 0.05$) in the grower phase and overall, resulting in 3.7% higher end-BW. Overall FI increased quadratically ($P < 0.05$), but GF was improved ($P < 0.05$) in the starter (quadratic effect) and grower (linear effect) phases by 5.0 and 3.4%, respectively. SDP increased BW uniformity quadratically ($P < 0.05$) by 4.2 points and increased the breast-meat pct cubically ($P < 0.05$) by 0.5 points. Thus, SPD improved performance and breast-meat pct.

Key Words: Broilers, Spray-Dried Plasma, Growth

W14 Comparison of biological efficacy of Alimet feed supplement and DL-methionine in broilers. K. M. Chee*¹, J. H. Choi¹, and M. K. Chung², ¹College of Life Sciences and Biotechnology, Korea University, Seoul Korea, ²Novus International Pte Ltd, Singapore.

Two methionine sources, Alimet feed supplement (Novus International, Inc.) and DL-methionine (DL-M), were added equimolar at two levels of supplementation to basal diets in order to estimate their relative bioefficacy in broilers. Added levels of Alimet or DL-M were 0.075 and 0.150% for the starter and 0.04 and 0.08% for the grower diets on dry weight basis, respectively. The higher supplemental levels were set to provide total sulfur-containing amino acids (TSAA) at requirements (NRC, 1994). Basal diets for starter and grower phases were deficient in TSAA and isocaloric (3,100 kcal AMEn/kg), containing 21 and 19% crude protein, and 0.67 and 0.62% TSAA, respectively. Diets were formulated in agreement with local commercial practice for broilers, and to provide other essential amino acids at a level at least 10% higher than recommended (NRC, 1994) when expressed as % of protein. Total 960, day-old, male and female (1:1) Ross broilers were allotted into four treatments with six replications each and 40 birds per pen. Overall bird performance during the starter phase (0-21 days) was not significantly different among dietary groups. However, during the grower phase (21-35 days) birds had higher weight gain ($P < 0.05$) when fed either methionine source at 0.08% compared to those fed at 0.04%. Weight gain and feed/gain ratios were not different ($P > 0.10$) at any time for any level of supplementation between birds fed Alimet or DL-M. Breast muscle and abdominal fat as % of body weight were not different among the treatments ($P > 0.05$). Cumulative performance (0-35 days) followed the same pattern of that observed during the grower stage. In conclusion, based on growth performance and carcass quality data, the bioefficacy of Alimet was not different from that of DL-M for broilers when compared on dry weight basis.

Key Words: Comparative Bioefficacy, Alimet and DL-methionine, Broiler

W15 AA requirements for broiler breeders at peak production. J. M. Sun, M. Debeer*, K. Bramwell, and C. N. Coon, *University of Arkansas, Fayetteville.*

Four hundred and eighty 32 week old Cobb-Vantress broiler breeders with similar body weight (3714 ± 172 g) and all laying were selected to determine the production requirement of dietary digestible methionine, lysine, phenylalanine, isoleucine, arginine, and CP in a 42 day feeding study. The average hen day egg productions for the beginning and for the 6 weeks period were 80% and 70%, respectively. The breeders were given a corn-soy basal diet plus crystalline amino acids with 8 graded levels of methionine, lysine, phenylalanine, isoleucine, and arginine representing 40% 130% of highest suggested requirement between NRC (1994) and Fisher (1998). All other amino acids were maintained at 100% of their suggested requirement level. The basal experimental diets utilized to determine the methionine and phenylalanine requirements contained added cystine and tyrosine, respectively, to supply the non-essential AA component of TSAA and phenylalanine plus tyrosine requirements. Glutamic acid was added to the basal diet containing 100% of essential amino acids to provide 80% 140% of suggested CP requirement (NRC, 1994). The breeders were fed 154 g feed (467 kcal ME) daily. Each treatment contained ten birds. The average egg weight multiplied by average hen day egg production multiplied by average daily wt gain was defined as g egg mass BW gain product. The average feed consumption divided by the product was defined as feed/product ratio. The digestible methionine, lysine, phenylalanine, isoleucine, arginine, and CP requirement for product and feed/product ratio was calculated to be 427.39 mg/d and 476.34mg/d, 888.91 mg/d and 899.02 mg/d, 643.53 mg/d and 667.54mg/d, 844.59 mg/d and 828.16 mg/d, 1059.45 mg/d and 1022.04 mg/d, 19880.72 mg/d and 18927.56 mg/d, respectively. Fertility was measured 4 times and the results showed that different AA levels had significant effects on fertility.

Key Words: AA Requirement, Broiler Breeder, Performance

W16 Dietary protein regulates short-term adaptations in lipogenic gene expression. R. W. Rosebrough*, B. A. Russell, S. M. Poch, and M. P. Richards, *Growth Biology Laboratory, ARS, USDA, Beltsville, MD.*

The purpose of these experiment was to determine possible relationships between certain indices of lipid metabolism and specific gene expression in chickens fed graded levels of dietary crude protein. Male, broiler chickens growing from 7 to 28 days of age were fed diets containing 12 or 30% protein ad libitum. Both groups were then switched to the diets containing the opposite level of protein. In Experiment 1, birds were killed on days 28 (basal values prior to the switch), 29, 30 and 31. Measurements taken included in vitro lipogenesis, malic enzyme activity the expression of the genes for malic enzyme, fatty acid synthase and acetyl coenzyme carboxylase. In Experiment 2, birds were sampled, again prior to the switch and at 3, 6, 9 and 24 hr. following the switch in protein levels. Measurements taken were confined to malic enzyme activity and the expression of the genes for malic enzyme, fatty acid synthase and acetyl coenzyme carboxylase. In vitro lipogenesis and malic enzyme activity were inversely related to dietary protein levels (12 to 30%) and to acute changes from 12 to 30%. In contrast, expression of malic enzyme, fatty acid synthase and acetyl CoA carboxylase genes appear to be constant over a dietary protein range of 12 to 21%, but are decreased by feeding a 30% protein diet (acute or chronic feeding). Results of the present study demonstrate a continued role for protein in the regulation of broiler metabolism. It should be pointed out that metabolic regulation at the gene level only occurs when feeding very high levels of dietary protein.

Key Words: Lipogenesis, Gene, Metabolism

W17 Efficacy of enzyme supplementation in laying hens fed diets based mainly on barley. M. I. Gracia*¹, A. Flores², E. McCartney³, M. Cortés¹, and J. Sánchez¹, ¹*Imasde Agropecuaria, S.L., S.L. Spain*, ²*Nutreco PRC, Spain*, ³*Pen&Tec Consulting, Spain.*

The aim of the present study was to evaluate the efficacy of a feed enzyme additive (Endofeed DC, EC No 25) containing 1,100 U/g of Endo-1,3(4)- β -glucanase (EC 3.2.1.6) and 1,600 U/g of Endo-1,4- β -xylanase (EC 3.2.1.8) in laying hens from 34 to 58 wks of age. A completely randomized design was applied using two experimental treatments: 1) basal

diet (control), and 2) basal diet with 125 mg/kg of enzyme, the recommended dose. Each treatment was replicated 10 times with 20 laying hens (400 Isa Brown in total) constituting the experimental unit. Egg production, average egg weight, and feed efficiency were calculated every 4 wks. Haugh Units, yolk color, and eggshell strength were measured every 8 wks. There were no significant differences between treatments in egg production or feed efficiency, but there were significant improvements in egg quality in hens supplemented with enzyme. For the overall period (34 to 58 wks of age), the addition of enzyme significantly increased mean egg weight (68.51 vs 69.71 g; $P < 0.05$) with no loss of shell quality. Enzyme supplementation increased both albumen height (8.70 vs 7.27 mm; $P < 0.01$) and Haugh Units (101.5 vs 95.0 ; $P < 0.01$) at 42 wks of age. There were significant improvements in yolk color due to enzyme, measured by both Roche Color Fan (RCF) and Minolta Colorimeter (L, a, and b values). Values were similar for both treatments at study start, but by 58 wks of age, hens supplemented with enzyme had significantly higher RCF values (13.34 vs 12.46 ; $P < 0.01$), lower luminosity (L) value (56.46 vs 57.66 ; $P = 0.06$), and significantly higher red color (a) value (6.26 vs 4.79 ; $P < 0.01$) than controls. Moreover, the a/b ratio, indicative of more intense color, was also increased significantly by enzyme supplementation ($P < 0.01$). The data from this study provide convincing evidence that enzyme improves egg weight and yolk color.

Key Words: Glucanase, Xylanase, Laying Hens

W18 Metabolizable energy of meat and bone meal processed differently in broiler diets. M. Moschini*¹, C. Cerioli¹, L. Fiorentini¹, M. Morlacchini², and G. Piva¹, ¹*Universita' Cattolica del Sacro Cuore Via Emilia Parmense, Piacenza-Italy*, ²*CERZOO San Bonico, Piacenza-Italy.*

The meat and bone meal (MBM) processed according to the 96/449/EC directive can still be used in animal diets in Europe. The safety of the processing may be improved when an alkaline step is added to the heat treatment. The apparent metabolizable energy (AME) and the AME corrected to zero nitrogen retention (AMEn) were assessed for differently processed MBM. The physical setting for MBM processing were: MBMA (100°C, 20 minutes, 3.5% CaO), MBMB (125°C, 20 minutes), MBMC (133°C, 20 minutes) (EC treatment) and MBMD (141°C, 20 minutes). 72 male broiler chickens (Ross), 1.8 ± 0.1 kg body weight, were individually housed and randomly assigned to 9 dietary treatments. The bulk of the base diet (Control) was corn (50%), soybean meal (33%), corn oil (3.4%) plus synthetic amino acids, minerals, trace minerals and vitamins. The MBM were used at two levels of substitution (L1=7%, L2=14%) of the protein from soybean of the base diet. Data were analyzed with the Dunnett type I experimentwise error comparison against the control diet. Diets with MBM were analyzed as a factorial experiment. The AME and AMEn of diets were 12.42, 11, 9.76, 12.87, 13.35, 10.46, 11.99, 12.36, 10.72 and 11.83, 10.24, 9.15, 12.19, 12.7, 9.77, 11.31, 11.67, 10.13 MJ/Kg dry matter, respectively for the control diet, MBMA L1, MBMB L1, MBMC L1, MBMD L1, MBMA L2, MBMB L2, MBMC L2 and MBMD L2. When compared to the control diet, no differences were detected. However, when analyzed as a factorial experiment, there were MBM ($P < 0.05$) and MBM by level interaction ($P < 0.05$) effects on the diet AME and AMEn contents. No level effect was observed. Contrast analysis for the AMEn within the L1 indicates 3.3 MJ/Kg dry matter difference ($P < 0.01$) of diets with MBM processed according to the EC treatment or at higher temperature versus the MBMB containing diet. Also, at the same level of substitution there was a -2.2 MJ/kg dry matter difference ($P < 0.05$) when comparing the diet containing the alkaline treated MBM versus diets containing MBM produced according to the EC treatment or at higher temperature. Using MBM processed according to EC treatment or at higher temperature did not negatively affect the AME or AMEn content of diets.

Key Words: Meat and Bone Meal, Metabolizable Energy, Poultry

W19 True metabolizable energy and amino acid digestibility of distillers dried grains with solubles. A. B. Batal* and N. M. Dale, *University of Georgia Poultry Science Dept., Athens.*

In recent years, policies encouraging the production of ethanol have stimulated an enormous increase in the production of distillers dried grains with solubles (DDGS). The ingredient which is becoming increasingly available differs from that of previous decades in that it is derived almost entirely from corn and is dried under less severe conditions.

Twelve DDGS samples were obtained from six different plants in the Midwest from 2002 to 2004. Each sample was analyzed for TME_n and four representative samples were analyzed for total and available amino acid content by using the precision-fed rooster assay with conventional or cecectomized single comb white leghorn roosters, respectively. Metabolizable energy (TME_n) ranged from 2379-3079 kcal/kg, with a mean of 2831 kcal/kg. Marked variation was noted between samples presumably reflecting modest differences in processing procedure. However, a reasonable consistency was observed in samples from the same suppliers. Considerable differences were observed between the true amino acid digestibilities of the DDGS samples. The majority of samples were golden in color and true amino acid digestibility values were relatively consistent among these samples. Total concentration and percent availability, of several critical amino acids for the golden DDGS samples were: lysine, 0.85% (75); methionine, 0.56% (89); cystine, 0.62% (75); threonine, 1.05% (76); and arginine, 1.25% (84). One DDGS sample was very dark in color, appearing to have been severely overheated during the drying process. The level of total amino acids and percent availability was much lower than that observed for the golden colored samples. Total concentration and percent availability, respectively, of several critical amino acids for the dark DDGS sample were: lysine, 0.64% (58); methionine, 0.047% (83); cystine, 0.50% (63); threonine, 0.92% (64); and arginine, 0.95% (75). The variation observed between samples strongly indicates that confirmatory analyses should be conducted prior to utilizing samples from a new supplier.

Key Words: Distiller's Dried Grains with Solubles, TME, Amino Acid Digestibility

W20 Modelling energy utilization in laying-type pullets. N. Sakomura^{*1}, R. Neme¹, F. Fialho², E. Carrilho¹, and K. Resende¹, ¹Faculdade de Ciências Agrárias e Veterinárias-Universidade Estadual Paulista Jaboticabal-SP - Brazil, ²EMBRAPA Bento Gonçalves -RS.

Three trials were conducted to elaborate the ME requirement models for two commercial laying-type pullet strains. In the first trial, 128 pullets with 9 weeks of age, Hy line Brown (HLB) and Hy line W36 (HLW36), were used to determine the efficiencies of energy utilization (kg) by the comparative slaughter method. In the second trial, the effect of temperature (12, 18, 24, 30, and 36°C) and feathering (0, 50, and 100%) were determined on ME maintenance requirements (ME_m) of two strains. The ME_m was determined by ME_m=MEI - RE/kg, MEI=ME intake, RE=retained energy. In the third trial, the ME requirement for weight gain was estimated based on body energy content per gram and kg. The lower critical temperatures (LCT) changed according to feathering levels (19, 22, and 24°C for 100, 50, and 0% of feathering). According to the equation ME_m=W^{0.75} 92.40+6.73(LCT-T), at temperatures below LCT, the ME_m increases 6.73 kcal/W^{0.75} /d for each increase of 1°C. At temperatures above LCT, the ME_m increases 0.88 kcal/W^{0.75} /d for each increase of 1°C (ME_m=W^{0.75} 92.40+0.88(T-LCT)). Considering these results, the following models were elaborated: ME=W^{0.75} 92.40+6.73(LCT-T)+3.22WG (TLCT) and ME=W^{0.75} 92.40+0.88(T-LCT) + 3.22WG (TLCT) for HLW36 and HLB from 1 to 6 wk-old; ME=W^{0.75} 92.40+6.73(LCT-T) + 4.94WG (TLCT) and ME=W^{0.75} 92.40+0.88(T-LCT) + 4.94WG (TLCT) from 7 to 12 wk-old, for HLB and ME=W^{0.75} 92.40+6.73(LCT-T) + 5.19WG (TLCT) and ME=W^{0.75} 92.40+0.88(T-LCT) + 5.19WG (TLCT) for HLW36; ME=W^{0.75} 92.40+6.73(LCT-T) + 6.32WG (TLCT) and ME=W^{0.75} 92.40+0.88(T-LCT) + 6.32WG (TLCT) from 13 to 18 wk-old for HLB and ME=W^{0.75} 92.40+6.73(LCT-T) + 9.49WG (TLCT) and ME=W^{0.75} 92.40+0.88(T-LCT) + 9.49WG (TLCT) for HLW36, ME=ME requirement (kcal/b/d), W=body weight (kg), LCT=24.54-5.65E (E is the feathering score from 0 to 1), T=temperature, WG=body weight gain (g).

Key Words: Energy Requirement Model, Laying Type-Pullets, Temperature

W21 Effect of different feedstuffs on endogenous energy losses of roosters. S. Zhaj^{*1}, G. Qi², and F. Liu¹, ¹College of Animal Science, Northwest Sci-Tech University of Agriculture and Forestry, Yangling Shaanxi, China, ² Feed Research Institute, Chinese Academy of Agriculture Science, Zhongguancun, Beijing, China.

This study was conducted to determine the endogenous energy losses (EEL) in intact roosters tube-fed Normal Corn(NC), Soybean Meal(SB)

and Fish Meal(FM), the levels of CP in NC, SB and FM were 8.7%,43.5% and 64.5%,fed basis. Twenty-four adult roosters(3.0±0.1kg, Body Weight) were allotted to three treatment groups, each of which included four replicates of 2 birds and kept in individual cages under a daily light period of 16h.Following a 48h period without feed, birds were given 50g of one of experimental feedstuffs via a crop intubation and their endogenous excreta were collected for the 48h-96h after intubation. The average EEL and nitrogen losses of per bird fed NC, SM and FM were found to be 83.78KJ and 1.75g, 92.04KJ and 1.9g, 97.80KJ and 2.11g, respectively. EEL and nitrogen losses of SB group and FM group were significantly higher than that of corn grain group (P < 0. 01), EEL of FM group was significantly higher than that of SB group (P < 0. 05). The EEL corrected to zero-nitrogen balance (EEL_n) for the NC, SM and FM group were 20.00KJ, 19.76KJ and 20.06KJ, there were not significantly difference between each group(P > 0. 1). The result showed that EEL would be affected by the protein level of the tube-fed feedstuffs significantly, but the EEL_n was independent of the tube-fed feedstuffs.

Key Words: Roosters, Endogenous Energy Losses, Endogenous Energy Losses Corrected to Zero-Nitrogen Balance

W22 Meeting metabolizable energy needs of broilers with corn-soy enzymes. A. N. Figueiredo¹, R. L. Dari^{*1}, E. E. M. Pierson², M. Hruby³, J. C. Remus², A. M. Penz¹, and T. H. D'Alfonso³, ¹Nutron Animal Nutrition Research Center Campinas, Sao Paulo, Brazil, ²Danisco Animal Nutrition, St. Louis, MO, ³Danisco Animal Nutrition, Marlborough, Wiltshire, UK.

Enzyme use (excluding phytase) in corn-soybean meal diets is relatively low in corn-sorghum-soy diets; this may be due to a lack of understanding of their practical application. A 24-pen, 42 day-D study was conducted to evaluate the effect of a corn-soy enzyme product (Avizyme[®] 1502: alpha-amylase, endo-xylanase and subtilisin protease; 1502) to meet the energy needs of broilers at different stages of growth. Each of four dietary treatments was randomly allocated to 6 replicate pens of Cobb 500 broilers (20 females:20 males/pen; 640 total). A four-phase feeding (pre-starter Brazilian broiler industry nutrient levels) program was used: (type-starter (PS; 00-07D); starter (S; 08-21D); Grower (G; 22-38D), and Finisher (F; 39-42D). There were two dietary treatments (Trts) in the PS and S phases: diets without (WO) and with (W) 0.05% 1502 added over-the-top. In the G and F phases, metabolizable energy (ME) was reduced (down specification; DS) by 3%. Performance of DS and normal ME diets W and WO 0.05% 1502 was compared. Calculated ME (kcal/kg) for the Trts were: PS-2950, S-3080; G-3085 or 3180; F-3153 or 3250. No significant differences between the Trts W and WO 1502 were observed at 7 and 21D. At 38 and 42D, there were significant effects (P < 0.01) of reducing ME on feed intake (FI) and FCR, and the addition of 1502 at each ME increased (P < 0.15) FI by ~ 40g and BW (P < 0.20) by ~ 25g. The average ME (highest ME diet, no 1502) intake (kcal/day) per phase was: PS (62), S (158), G (466), and, F (546). These data suggest that: the broiler to 21D may respond differently to 1502 than it does after this age; there is room for improving the predictability of dietary response to 1502; addition of 1502 OTT through 21D and then to diets with ME reduced 3% is a viable tool to economically meet the energy needs of the broiler.

Key Words: Corn-Soy Enzymes, AME, Over the Top

W23 Validation of dual energy X-ray absorptiometry (DXA) bone mineralization measures in broilers as an alternative to bone ash and breaking measures. R. Angel^{*1}, A. D. Mitchell², and M. Christman¹, ¹Univ. of Maryland, College Park, ²USDA, Agricultural Research Service, Beltsville, MD.

Bone mineralization status of chickens has traditionally been measured using techniques that generate values such as bone ash, bone breaking strength and force, etc. Most traditional techniques are time consuming and require extensive work related to bone removal and further laboratory work. Use of DXA allows for quick measures of bone mineral content (BMC, g) and density (BMD, g/cm²) on the whole carcass, carcass parts or excised bones. The objective of this study was to determine whether DXA measures can be used to predict traditional measures such as bone ash and breaking strength in whole carcasses as well as in excised bones. Traditional measures used included ash (done on toes, shank, tibia and femur), breaking strength and breaking force (done on tibia and femur). Whole carcasses (270) and excised bones from these carcasses were obtained from a study where broilers were fed diets with

different calcium and phosphorus levels. Broilers were sampled at different ages between 18 and 53 d and within each age, were subdivided at random into two subsets (85 and 15% of the data set). Using the 85% subset (n=225), regressions of each adjusted ash and strength variables were run against each adjusted BMC and BMD variable and regression equations and R² values obtained. These equations were used to predict bone ash and strength variables based on measured DXA variables in the remaining 15% of the data set (n=45). The partial R² values were high between DXA whole body BMC and g of femur (0.82) and tibia (0.80) ash. When DXA measures were used to predict bone ash in the 15% subset based on the regression relationships, correlations between predicted and actual values were high. When DXA whole body and femur BMC measures were used to predict femur ash the R² between predicted and actual was 0.86 and 0.89, respectively. DXA generated BMC values can be used to predict bone ash.

Key Words: Bone Mineralization, Dual Energy X-ray Absorptiometry

W24 A novel organic selenium source (zinc-L-selenomethionine, Availa[®]Se) for broilers. B. George¹, S. Davis¹, and T. L. Ward*², ¹Colorado Quality Research, Wellington, ²Zinpro Corporation, Eden Prairie, MN.

There is renewed interest in Se supplementation of livestock due to research showing forms of organic Se are more bioavailable than sodium selenite (NaSe). The objective of this research was to evaluate zinc-L-selenomethionine (ZnSeMet; Availa[®]Se, Zinpro Corp.) in broilers. A randomized complete block design experiment was conducted using day-old RossxRoss 508 male and female chicks. Chicks were fed: 1) corn-SBM diet without Se supplementation (Control), 2) Control + 0.3 ppm Se as NaSe, or 3) Control + 0.3 ppm Se as ZnSeMet. Twelve pens (6 female and 6 male) were used per treatment with 50 females or 45 males per pen. Diets were fed for 49 d in three phases (starter, 0-16 d; grower, 17-35 d; finisher, 36-49 d). Three birds per pen were bled at the end of the study to determine plasma glutathione peroxidase activity (GSH-Px) and Se concentrations, and pectoralis muscle samples were collected to determine Se content. Birds fed NaSe had lower final BW (2.543, 2.408, 2.505 kg for Control, NaSe, ZnSeMet, respectively) and higher feed/gain (1.740, 1.776, 1.733) than birds fed Control or ZnSeMet. Muscle moisture loss was higher numerically in birds fed NaSe compared to birds fed Control or ZnSeMet (1.27, 1.42, 1.25%). Plasma GSH-Px activities were lower (P<0.05) in birds fed Control vs Se-supplemented diets (10.4, 14.0, 15.4 U/mg protein). Birds fed NaSe had lower (P<0.05) plasma GSH-Px than birds fed ZnSeMet. Plasma Se was higher (P<0.01) in birds fed NaSe or ZnSeMet than in birds fed Control (0.113, 0.144, 0.179 ppm). Plasma Se was higher (P<0.05) in birds fed ZnSeMet than birds fed NaSe. Breast muscle Se concentration was higher (P<0.01) in birds fed ZnSeMet compared to birds fed Control or NaSe (0.393, 0.422, 1.20 ppm DM). Higher Se concentration in muscle of broilers fed ZnSeMet is consistent with selenomethionine being incorporated into proteins in place of methionine. Increased muscle stores of Se when feeding ZnSeMet, indicate a more bioavailable Se source relative to NaSe. Zinc-L-selenomethionine is an efficacious source of Se for poultry.

Key Words: Broiler, Selenium, Zinc-L-Selenomethionine

W25 Interactive effects of Zn, Cu, and Mn supplementation in diets for chicks. J. L. Shelton* and L. L. Southern, Louisiana State University Agricultural Center, Baton Rouge.

Previous research in our lab with pigs indicated that removing the dietary trace mineral premix, which contained Zn, Mn, Cu, Se, Fe, and I, resulted in an increase in Mn and a decrease in Zn concentrations in various tissues. Therefore, an experiment was conducted to determine the interactive effects of Zn, Cu, and Mn addition to diets of 0 to 14-d old chicks on growth performance, bone strength, bone ash percentage, and tissue mineral concentrations. Two levels of Zn (0 and 75 ppm, as Zn sulfate), two levels of Mn (0 and 100 ppm, as Mn sulfate), and two levels of Cu (0 and 7 ppm, as Cu sulfate) were supplemented to corn-soybean meal diets in a 2x2x2 factorial arrangement. Each treatment had six replications with five chicks each, and the initial and final BW were 46 and 382 g. Daily gain, daily feed intake, gain:feed, bone strength, bone ash percentage, and bone and pancreatic Zn concentrations were increased (P < 0.07) in chicks fed the diets with supplemental Zn. Daily gain was decreased and bone, liver, and pancreatic Mn levels were increased in chicks fed diets with Mn addition (P < 0.09). Bone

strength was increased when Zn was added to the diets with or without Cu addition but the increase was greater in chicks fed the diets without Cu addition (Zn x Cu, P < 0.05). Bone ash percentage was increased in chicks fed the diets with Zn, Mn, or Cu addition but the increase was not additive (Zn x Mn x Cu, P < 0.03). Liver Cu level was increased (P < 0.01) in chicks fed the diets with Cu addition. Bone and liver Cu levels were decreased (P < 0.07) in chicks fed the diets with Zn addition. Liver and pancreatic Mn levels were increased (P < 0.07) in chicks fed the diets with Zn addition. This study indicated that Zn addition is necessary for normal growth performance and bone strength of chicks, and that Zn addition had a negative effect on tissue Cu levels and a positive effect on tissue Mn levels.

Key Words: Chicks, Growth, Trace Minerals

W26 Phosphorus availability of distiller's dried grains plus solubles for male turkey poults. J. L. Kalbfleisch* and K. D. Roberson, Michigan State University, East Lansing.

Two experiments were conducted to determine the P availability of distiller's dried grains plus solubles (DDGS) using the slope ratio method. In each experiment, 360 male turkey poults were started at one day of age and fed a low P diet (0.5% non-phytate P (nPP)) for 7 or 6 days, respectively. In both experiments, diets were isocaloric, isonitrogenous and calcium was kept constant at 1.2%. DDGS was analyzed to contain 0.69% TP and 0.29% nPP. In Experiment 1, 8 to 9 poults were randomly sorted into 42 brooder cage pens and fed 1 of 7 dietary treatments from 7 to 14 days of age. Treatments were formulated on nPP basis and consisted of the following composition: (1) corn-soybean meal basal (nPP=0.25%), (2) basal + 0.04% nPP from dicalcium P (DP), (3) basal + 0.08% nPP from DP, (4) basal + 0.12% nPP from DP, (5) basal with 15% DDGS (0.29% nPP), (6) basal with 30% DDGS (0.33% nPP), (7) basal with 45% DDGS (0.37% nPP). Body weight (BW), feed intake, ricket scores and bone ash were measured. At the highest level of nPP in Experiment 1, bone ash was significantly greater with DDGS than DP (P<0.0001). Based on nPP intake, P availability was determined to be 76.5% for bone ash (%), 70% for gain and 81% for gain:feed. In Experiment 2, 7 to 8 poults were randomly sorted into 42 brooder cage pens and fed 1 of 7 dietary treatments from 6 to 14 days of age. Treatments were formulated for total P (TP) and consisted of the following composition: (1) corn-soybean meal basal (0.58% TP), (2) basal + 0.05% P from DP, (3) basal + 0.1% P from DP, (4) basal + 0.15% P from DP, (5) basal with 13% DDGS (0.63% TP), (6) basal with 26% DDGS (0.68% TP), (7) basal with 40% DDGS (0.73% TP). At 0.73% TP, ricket score and bone ash (%) were significantly greater with DDGS than DP (P<0.002; P<0.0001). Based on TP intake per gm gain, regression analysis showed P availability from DDGS was repeatedly greater than DP. Based on total P formulation, dicalcium P may not be the appropriate standard to measure P availability of DDGS and suggests P in DDGS is greater than 85% available.

Key Words: DDGS, P Availability, Turkeys

W27 Effect of supplementing selenium yeast in diets of laying hens on egg selenium content. P. Utterback*¹, C. Parsons¹, I. Yoon², and J. Butler², ¹University of Illinois, Urbana, ²Diamond V Mills, Inc, Cedar Rapids, IA.

An eight-week experiment was conducted using 90 Hy-Line W-98 hens (26 wk of age) to evaluate the use of organic selenium (Se) from Se yeast as a Se source for laying hens. At 22 wk of age, the hens were placed on a low Se corn-soybean meal pretest diet for four weeks. At the end of the pretest period, hens were placed on one of three experimental treatments; the low Se diet without supplementation (basal diet), basal diet with 0.3 ppm of Se added from sodium selenite, or basal diet with 0.3 ppm of Se added from Se yeast (SelenoSourceAF#8482, Diamond V Mills, Inc. Cedar Rapids, IA). The diets contained 0.11, 0.38 and 0.34 ppm of Se, respectively. Each of the experimental diets was fed to 10 replicate groups of three hens for eight weeks (26 to 34 weeks of age). Selenium levels in eggs (mg per kg of whole egg) were analyzed at the end of the pretest period (Week 0), Week 4, and Week 8. Initial egg Se contents at Week 0 were similar among treatments (Table 1). Eggs from hens fed the two Se-fortified diets had higher (P < 0.01) Se concentrations than did eggs from hens fed the low Se control diet at both Week 4 and Week 8. The Se yeast diet also yielded egg Se levels that were significantly higher (P < 0.01) than those from the sodium selenite diet at Week 4 and Week 8. The Se yeast resulted in a 4.8-fold increase

in egg Se concentration compared to a 2.8-fold increase for the sodium selenite diet over the unsupplemented diet at Week 8. There were no differences in egg production, egg weight, feed intake, or mortality among treatments. The results of this study indicate that use of Se yeast in laying hens diets is very effective for increasing the Se content of eggs. Effect of sources of Se on egg Se content.

Egg Se content ppm	Diet			SEM
	Basal	Sodium Selenite	SelenoSourceAF™	
Week 0	0.101 ^a	0.104 ^a	0.103 ^a	0.005
Week 4	0.087 ^c	0.180 ^b	0.301 ^a	0.015
Week 8	0.065 ^c	0.182 ^b	0.311 ^a	0.010

^{a-c}Means within a row with different superscripts differ significantly ($P < 0.01$).

Key Words: Selenium, Se Yeast, Sodium Selenite

W28 Effects of withdrawing vitamin and or trace mineral premixes from grower and finisher diets of broiler. A. Kamyab, A. M. Hosseini*, R. Mohammadzadeh, and K. Taherpour, *University of Tehran, Karaj, Iran.*

Supplementing broiler diets with vitamin and mineral premixes are of concern. This concern is warranted due to the relative quantities needed and due to the adverse effects on the broilers that occur when inadequate dietary levels are fed. The objective of this experiment was to evaluate the effect of withdrawing vitamin and or mineral premixes from the grower and finisher diets of broilers. This experiment was arranged as a 2x4 factorial design. The factors being; a) supplement (ctrl) or non-supplementing one or both premixes in the diets and, b) two withdrawal times, 28 to 49 and 35 to 49d. Birds from each of the eight treatment combinations were assigned to four replicate pens of 30 birds each. Withdrawing of one or both premixes between 28 to 35 days of age had no significant ($P > 0.05$) effects on body weight gain (BWG), feed efficiency (FE), and feed intake (FI). At the second withdrawing period, FI for birds fed diet with no vitamin supplement was statistically lower ($P < 0.05$) than other treatment groups. Likewise, BWG for group without vitamin supplement and those, which lacked both premixes, were lower ($P < 0.05$) than other groups. Birds fed diet lacking mineral supplement had the worst FE, but this difference was only statistically significant ($P < 0.05$) with the group fed lacking both vitamin and mineral supplement. Other criteria such as carcass characteristics, mortality and incidence of leg disorders were not statistically affected by treatments in the entire of this experiment ($P > 0.05$). Our finding indicates that withdrawing premixes between the ages of 28 to 35 has little or no carry over effect on broiler performance.

Key Words: Broiler, Mineral, Vitamin

W29 Use of phytase and an enzyme complex containing α -amylase, xylanase and protease in commercial layers. J. González*, S. Cornejo, E. Contreras, B. Díaz, and L. Vera, *Universidad de Chile, Facultad de Ciencias Veterinarias y Pecuarias, Santa Rosa, La Pintana Santiago Chile.*

A 35-wk study was conducted to evaluate the effects of 3-phytase (5000 FTU/g from *Trichoderma reesei*) and an enzyme complex (EC=Avizyme^R 1502) in layer diets based on corn, soy and wheat bran on performance, egg quality and ileal nutrient digestibility. One hundred forty-four 18-wk-old layers (HyLine W-36) were randomly assigned to 4 treatments with 3 replicates each (4 hens/cage) in a 2 x 2 factorial design. The treatments: 1) no enzyme supplementation, 2) Phytase (300 FTU/kg), 3) EC (α -amylase 300 U/kg, xylanase 225 U/kg and protease 3000 U/kg) and 4) Phytase + EC. All diets provided 86% and 92% of the daily AMEn and CP requirements of layers, respectively. Phytase inclusion provided the equivalent of .11% available P and .1% Ca in treatments 2 and 4. The use of phytase increased ($p < .05$) egg production (EP) and cumulative eggs/h/h (CE) by 1.16% and 2.45 eggs, respectively. The use of the EC decreased ($p < .05$) EP by .66%. Interactions ($p < .05$) were observed for egg weight (EW) and feed intake (FI). In the absence of EC, EW was not affected ($p < .05$) by phytase, however in the presence of EC, phytase decreased EW by .89g. Phytase + EC did not affect FI, however FI decreased when both phytase

and EC were added. Specific gravity was decreased ($p < .05$) while yolk color, yolk weight, yolk/albumen ratios by weight and volume, were increased ($p < .05$) by EC. Phytase decreased ($p < .05$) shell thickness and breaking strength. The EC improved ($p < .05$) AME (10%), P (30%) and protein (6%) digestibilities, but phytase did not influence ($p > .05$) nutrient digestibility. The parameters measured were not further improved ($p > .05$) by the combined use of both phytase and EC. In the present study, phytase improved layer performance but decreased egg shell quality. The EC improved egg quality and nutrient digestibility. The effect of α -amylase, xylanase and protease on P ileal digestibility deserves further research.

Key Words: Laying Hen, Enzymes, Ileal Digestibility

W30 Effect of microbial phytase in low phosphorus and calcium level diet on the performance and nutrient digestibility in laying hens. B. J. Min^{*1}, O. S. Kwon¹, W. B. Lee¹, K. S. Son¹, J. W. Hong¹, T. H. Moon², Y. K. Han³, and I. H. Kim¹, ¹*Department of Animal Resource & Science, Dankook University Cheonan, Korea,* ²*InterMax System, Inc., Korea,* ³*Livestock Research Institute, National Agricultural Cooperatives Federation, Korea.*

This study conducted to investigate the effects of microbial phytase in low phosphorus and calcium level diet on the performance and nutrient digestibility in laying hens. One hundred ninety two, 50-wks old, ISA brown commercial layers were used in a 12 weeks feeding trial after 7-d adjustment period. Four dietary treatments included CON(control; corn-soybean meal basal diet contained available P and Ca to meet the NRC requirement), P1(0.01% PHYTEX, Agranco, Co.), P2(0.06% Natuphos, BASF) and P3(0.06% PHOSMAX, GENOFOCUS). Ca and available P concentrations of P1, P2 and P3 were 90% and 50% of NRC recommendations to accentuate difference in response to phytase availability. In whole period, egg production was not affected by treatments. At 12 weeks, egg weight was significantly increased in adding phytase treatments ($P < 0.05$). Egg shell thickness was increased in P1, P2 and P3 treatments compared with control ($P < 0.05$) at 9 weeks. Ca concentration of serum was tended to decrease in P1 treatment without significant difference ($P > 0.05$). Ca and P concentrations of tibia were higher in layers fed dietary phytase than layers fed control diet without significantly difference ($P > 0.05$). Digestibilities of DM, N and ash were improved in P1 treatment compared with P2 and P3 treatments ($P < 0.05$). Ca and P digestibilities were the highest in P2 treatment ($P < 0.05$), however, there was not significant difference between control and P1 treatments.

Key Words: Microbial Phytase, Performance, Laying Hens

W31 Market tom turkey performance and dietary phytase inclusion. S. L. Noll^{*1}, J. Brannon¹, and J. S. Sands², ¹*University of Minnesota, St. Paul,* ²*Danisco Animal Nutrition, Marlborough, Wiltshire, UK.*

Inclusion of dietary phytase has been identified as a means to reduce dietary phosphorus content and ultimately the environmental impact of poultry manure by reducing its phosphorus content. Appropriate inclusion levels need to be determined in commercial type diets. A novel 6-phytase expressed in yeast (Phyzyme XP, Danisco Animal Nutrition) was assayed for efficacy in market tom turkey diets in a 16-wk trial. Turkey poults (Large White, Nicholas strain) were randomized into floor pens (12 /pen, six replicate pens per treatment) at d of age and were fed one of eight test diets to 16 wks of age. The eight dietary treatments were: 1) positive control (PC) with NRC (1994) levels of calcium and available phosphorus; 2) negative control (NC) with calcium and available phosphorus reduced by .2%. For Treatments 3-6, the NC diet series was supplemented with phytase and contained analyzed phytase levels of 160, 325, 500 and 650 FTU/kg feed, respectively. Adjustments in the nutrient content of the corn-soybean based basal diet were made for each 4-wk feeding period. The turkeys were weighed initially at the start of the trial and at 4, 8, 12, and 16 wks of age with corresponding measurements of feed intake. At 16 wks of age, four birds from each pen were euthanized for toe ash determination. Body weight (BW) at 8, 12, and 16 wks and toe ash was poorer for NC in comparison to PC turkeys as was cumulative feed intake and feed efficiency (FE) through 16 wks of age ($P > .05$). Phytase supplementation improved performance over NC. Performance equivalent to PC was obtained although optimal level of supplementation changed with the age of the bird. Through 8 wks of age, BW and FE for turkeys fed 160 FTU/kg resulted in performance similar to PC while through 16 wks of age, 500 FTU/kg resulted

in performance similar to the positive control. In conclusion, phytase supplementation restored performance in turkeys fed diets deficient in calcium and phosphorus. Optimal performance to 16 wks of age was obtained when the diet was supplemented with 500 FTU/kg of Phyzyme XP.

Key Words: Turkey, Phosphorus, Phytase

W32 Market turkey performance and inclusion level of corn distillers dried grains with solubles. S. L. Noll*¹, J. Brannon¹, and V. Stangland², ¹University of Minnesota, St. Paul, ²Stangland Feed Consulting, Willmar, MN.

Inclusion of corn distillers dried grains with solubles (DDGS) in poultry diets is usually limited to less than 10% of the diet. Depending on price of DDGS and other ingredients, inclusion levels may exceed 10% in ration formulation. A study was conducted with market tom turkeys to determine if higher levels could be fed without negative effects on performance and if dietary protein regime would change the response. A factorial design of inclusion level (0, 10, 15, and 20% DDGs) and protein regime (95 and 100% NRC threonine (thr)) was used to determine if an interaction existed between DDGs inclusion level and dietary protein regime. Male turkeys (Large White) were randomly assigned to pens (10 birds/pen) at 8 wks of age and were fed one of the test diets to 19 wks of age (7 replicate pens per treatment). Diets were formulated to be isocaloric and with similar levels of digestible lysine and TSAA. Diets were adjusted for nutrient content at 3-wk intervals. Turkeys were weighed individually at 8, 11, 14, 17, and 19 wks age. Feed intake was measured for each feeding period. Level by protein regime was significant for body weight (BW) at 11, 14, and 17 wks of age ($P < .05$). At 100% NRC thr, turkeys fed 10 and 15% DDGS tended to have better performance than 100% NRC thr. At 95% NRC thr, 10% and 15% inclusion tended to depress BW at 14 and 17 wks of age. Feed efficiency responses were similar to those of body weight. Based on live performance, up to 20% DDGS can be incorporated into market turkey diets. At the higher protein regimen, inclusion of 10 and 15% DDGS improved weight over that of the control.

Key Words: Turkey, Corn, Distillers Grains

W33 Efficacy of Phyzyme[®] XP phytase in broiler diets containing different levels of calcium and non-phytate phosphorus: nitrogen retention and ileal amino acid digestibility. D. R. Ledoux*¹, J. N. Broomhead¹, and J. S. Sands², ¹University of Missouri, Columbia, ²Danisco Animal Nutrition, Marlborough, Wiltshire, UK.

A six-week floor pen study was conducted to determine the efficacy of Phyzyme[®] XP, in diets containing different Ca & P levels, on nitrogen retention, and ileal amino acid digestibility in broiler chickens. A 3 X 4 factorial arrangement of dietary treatments from hatch to week 3 included 3 Ca & non-phytate P (npP) levels (0.80 & 0.25%, 0.85 & 0.30%, and 0.90 & 0.35%) and 4 levels of Phyzyme[®] XP (0, 250, 500, and 750 U/kg diet). From week 3 to 6, dietary phytase levels were kept the same but Ca & npP levels were reduced (0.70 & 0.15%, 0.75 & 0.20%, and 0.80 & 0.25%). The starter basal diet contained 21.74% CP and 2920 kcal ME/kg, and the grower basal diet contained 19.5% CP and 3010 kcal ME/kg. Six pens of 25 chicks each were assigned to each dietary treatment from day 1 to 42. Significant ($P < 0.05$) interactive and main effects were observed for 3 week nitrogen retention, whereas at 6 weeks there was only a significant ($P < 0.05$) phytase effect. Phytase supplementation improved nitrogen digestibility by an average of 4.3% at week 3, and by 4.4% at week 6. With the exception of tryptophan and serine, significant ($P < 0.05$) interactive and main effects were observed for ileal digestibility of both essential and nonessential amino acids. Ileal digestibility of tryptophan and serine, were affected ($P < 0.05$) by phytase level and by the interaction of Ca & npP and phytase level. For the essential amino acids, phytase supplementation improved average ileal digestibility by 2.2%, whereas for the nonessential amino acids improvements in ileal digestibility averaged 3.2%. These results indicate that Phyzyme[®] XP was effective in improving nitrogen and amino acid utilization, and the efficacy was influenced by Ca & npP level.

Key Words: Phytase, Amino Acid Digestibility, Broilers

W34 Effects of phytase on the bioavailability of phosphorus in diets containing conventional or low-phytate corn and soybean meal for chicks. E. G. Xavier, G. L. Cromwell*, and M. D. Lindemann, University of Kentucky, Lexington.

An experiment was conducted to assess the effects of phytase (Natuphos[®], BASF; 750 units/kg) on the bioavailability of P in normal (N) corn and N soybean meal (SBM) or near-isogenic, low-phytate (LP) corn and LP, low-oligosaccharide SBM from near-isogenic soybeans. The corn and SBM were provided by Pioneer Hi-Bred International. The N-corn, LP-corn, N-SBM and LP-SBM contained 0.25, 0.26, 0.70, and 0.77% total P and 0.05, 0.17, 0.22, and 0.55% non-phytate P. Chicks (3-d-old, 85 g initial weight) were fed a low P (0.24% P) phytate-free, casein-dextrose-sucrose-starch basal diet (1.36% lysine, 0.91% methionine) or the basal with 0.08 and 0.16% added P from monosodium phosphate (MSP). Eight additional diets consisted of the basal with 0.08 or 0.16% added P from a 2:1 blend of N-corn and N-SBM or a 2:1 blend of LP-corn and LP-SBM. These eight diets were fed either without or with phytase. All diets contained 1.0% Ca and 3.56 Mcal ME/kg. Diets were fed for 14 d to five replications of six chicks per pen in batteries. Rate and efficiency of gain, and bone strength and ash increased linearly ($P < 0.05$) with increasing level of dietary P. At the end of the study, all chicks were killed and tibias were removed for breaking strength and ash determinations. Because of low feed intake (thus low P intake) along with uncharacteristically low bone strengths and ash in chicks fed the basal and MSP diets, we were unable to use slope-ratio procedures for determining P bioavailability. However, based on relative responses in tibia strength and ash weight, and assuming from previous studies in our laboratory that the bioavailability of P in the 2:1 blend of N-corn + N-SBM diet without phytase was 20% and in the 2:1 blend of LP-corn + LP-SBM without phytase was 55%, the addition of phytase to these two diets increased the estimated bioavailability of P to 43% and 73%, respectively. The results indicate that phytase, at 750 units/kg, converted approximately one-third of the unavailable P in both types of corn-SBM diets to an available form.

Key Words: Chicks, Phosphorus, Phytase

W35 Influence of phytase enzyme supplementation on the growth performance of broiler chicks. A. S. Hussein* and A. M. Yousif, United Arab Emirates University College of Food Systems, Al-Ain, UAE.

The influence of phytase enzyme supplementation on the performance of broiler chicks fed starter diets containing varying levels of a commercial phytase enzyme (phyzyme, Finnfeeds Danisco Cultor) was investigated using low-phosphorus diets. Four replicate groups of eighteen commercial broiler chicks, one day old, were randomly assigned to each of the four dietary treatments. The diets were isonitrogenous (22.25% CP) and isocaloric (3.05 Mcal/kg). Diet 1 (Control) was a corn-soybean starter diet containing 1.0% Ca and 0.45% available P without added phytase enzyme. Diets 2, 3, and 4 were corn-soybean diets containing 1.0% Ca and 0.26% available P with 0, 500 and 1000 added phytase units/kg, respectively. Average body weight and feed intake were measured after 3 weeks and feed conversion ratio was calculated. Blood samples were obtained at the end of the three-week trial in order to measure plasma inorganic P, total Ca, Mg, K, Zn, Fe and Cu. Body weight gain of broiler chicks receiving a diet deficient in phosphorus (Diet 2) with no added phytase enzyme was significantly decreased ($P < 0.05$) compared to the Control and the other treatments. Also, body weight gain of broiler chicks fed the Control (Diet 1) and the low-phosphorus diets with added phytase enzyme (Diets 3 and 4) was similar. Total feed intake and feed conversion ratio were not significantly affected between treatments. However, these parameters were depressed in the phosphorus-deficient treatment (Diet 2). The data showed that graded levels of phytase enzyme added to phosphorus-deficient broiler starter diets significantly increased body weight in a linear fashion.

Key Words: Phytase, Broilers, Growth Performance

W36 The use of near-infrared reflectance spectroscopy to predict the moisture, dry matter, nitrogen, total phosphorus, and phytase phosphorus contents in broiler litter. R. I. Bakalli¹, T. J. Frost², G. M. Pesti*¹, J. P. Driver¹, and H. M. Edwards, Jr.¹, ¹University of Georgia Poultry Science Dept., Athens, ²Gold Kist, Inc, Atlanta, GA.

One hundred thirteen litter samples were obtained from 9 commercial broiler houses in Georgia to develop calibrations for NIRS predictions of moisture, dry matter, total nitrogen, total phosphorus, and phytate phosphorus. The samples were scanned in a Feed & Forage Analyzer Model 5000 with near-infrared reflectance spectroscopy using routine operation and calibration software WIN ISI-IIc.

Table legend: n = Number of samples used in calibration set for regression. Means = Mean is the average of the constituent lab values used in the calibration. RSQ (R²) = Coefficient of determination. SD = Standard deviation among laboratory values. SEC = Standard error of calibration. SECV = Standard error of cross validation. 1-VR = Is 1 minus the variance or a correlation between the laboratory data and the cross validation results.

The sample compositions by chemical assay versus NIRS predictions were (mean±SE, CV%): moisture 6.15±0.18, 30.78 vs 5.99±0.16, 28.46; total dry matter 71.56±0.76, 28.46 vs 72.51±0.74, 10.85; total nitrogen 3.91±0.07, 17.98 vs 3.84±0.06, 15.89; total phosphorus 1.61±0.03, 22.16 vs 1.59±0.03, 22.21; phytate phosphorus 0.70±0.02, 31.00 vs 0.67±0.02, 25.02. NIRS can be a useful tool in the prediction of moisture, total dry matter, total nitrogen, total phosphorus and phytate phosphorus in litter samples from commercial broiler houses.

Results of the near-infrared reflectance spectroscopy calibration set for broiler litter composition

Constituent (%)	n	Mean	RSQ	SD	SEC	SECV	1-VR
Sample Moisture	49	5.83	0.917	1.936	0.559	0.800	0.838
House Dry Matter	49	71.15	0.943	10.049	2.399	4.043	0.845
Total Nitrogen	47	3.85	0.880	0.623	0.216	0.376	0.637
Total Phosphorus	46	1.55	0.966	0.354	0.066	0.098	0.926
Phytate Phosphorus	46	0.62	0.928	0.170	0.046	0.069	0.840

Key Words: Litter, Phosphorus, Nitrogen

W37 Bioefficacy of probiotics in broiler diets. M. I. Gracia*¹, R. M. Engberg², A. E. Espinel³, M. Cortés¹, and F. Baucells¹, ¹Imasde Agropecuaria, S.L., Spain, ²Danish Institute of Agricultural Sciences, Denmark, ³Norel, S.A., Spain.

Two experiments were conducted to evaluate the efficacy of dietary supplementation with probiotics on performance of broiler chickens. In each experiment, 720 Ross 208 d-old broilers distributed at random in 8 replicates of 30 birds per treatment were used. The experimental design was applied to a grower (0 to 21 d) and a finisher diet (21-42 d), both pelleted and based on wheat, barley and corn. In experiment I, there were three treatments, a basal diet (control) and two levels of inclusion of *Enterococcus faecium* CECT 4515 (containing 10⁹ CFU/g product): 100 and 1,000 g/t. At 21 d of age, *E. faecium* supplementation at the higher dose significantly improved ADG (P<0.05) and feed conversion (FC) (P<0.001) (28.2, 28.9, 29.5 g/d, and 1.46, 1.43, 1.40 g feed/g gain; for control, 100g/t, and 1,000 g/t, respectively). However, significant differences disappeared thereafter. In experiment II, the same experimental design as in experiment I was applied with two levels of inclusion of *Bacillus coagulans* CECT 5940 (containing 10⁹ CFU/g product): 100 and 1,000 g/t. At 21 d of age, *B. coagulans* supplementation at the higher dose significantly improved ADG (P<0.05) and FC (P<0.001) (28.2, 28.2, 29.2 g/d, and 1.46, 1.44, 1.42 g feed/g gain; for control, 100g/t, and 1,000 g/t, respectively). However, no differences between treatments were found at 42 d of age. These results indicate that the probiotics tested improve growth and FC until 21 d of age, but these improvements were not maintained thereafter.

Key Words: Probiotics, Performance, Broilers

W38 Effect of a probiotic containing two *Lactobacillus* strains on growth performance and population of bacteria in the ceca and carcass rinse of broiler chickens. A. C. Murry, Jr.*¹, A. Hinton, Jr.², and R. J. Buhr², ¹The University of Georgia, Athens, ²USDA/ARS.

This study was conducted to examine the effect of feeding a botanical probiotic (Feed FreeTM) containing two strains of *Lactobacillus* (*L. salivarius* and *L. plantarum*) on growth performance and bacteria populations in the ceca and carcass rinse of broiler chickens. Four hundred fifty day of hatch high yield strain male broiler chicks were placed into 20 pens with 30 broilers per pen. The dietary treatments were the basal diet (control with coccidiostat and antibiotic), basal diet without coccidiostat and antibiotic and supplemented with 0.10%, or 0.20% probiotic. The results showed that from 1 to 49 d of age body weight gain for broilers fed diets supplemented with 0.10% or 0.20% probiotic was not different (P > 0.05) from birds fed diets with or without coccidiostat and antibiotic. Feed intake and feed to gain ratio from 1 to 42 d of age were higher (P < 0.001) for broilers fed the control diet than for those fed 0.10% or 0.20% probiotic and those without coccidiostat and antibiotic. Feed intake and feed to gain ratio were not different (P > 0.05) between broilers fed 0.10% or 0.20% probiotic and those fed diets with and without coccidiostat and antibiotic. The population of *Campylobacter jejuni* and *Escherichia coli* recovered from carcass rinses at 56 d of age were not different (P > 0.05) due to treatment. Also, *Lactobacilli* and *Escherichia coli* recovered from ceca contents at 56 d of age for were not different (P > 0.05) due to treatment. These results suggest that diets supplemented with the natural probiotic containing *L. plantarum* and *L. salivarius* supports growth for broilers similar to the basal diet supplemented with antibiotic and coccidiostat, and with lower feed to gain ratio.

Key Words: Probiotic, Broiler Chickens, Growth Performance

W39 Comparison of broiler performance when fed diets containing insect-protected (MON 88017 or MON 88017 x MON 810), control, or commercial corn. M. L. Taylor*¹, B. George², Y. Hyun¹, M. A. Nemeth¹, K. Karunanandaa¹, and G. F. Hartnell¹, ¹Monsanto, Co., LLC, St. Louis, MO, ²Colorado Quality Research, Inc, Wellington.

A 42-day study using Ross x Ross 508 broiler chickens was undertaken to compare the nutritional value of diets containing MON 88017 or MON 88107 x MON 810 corn as compared to those containing the genetically similar control corn or commercially available conventional varieties of corn. MON 88017 corn produces a variant of the wild-type Cry3Bb1 protein, that protects against feeding damage caused by corn rootworm larvae (CRW; *Diabrotica sp.*) and also produces the 5-enolpyruvylshikimate-3-phosphate synthase protein from *Agrobacterium sp.* strain CP4 (CP4 EPSPS), that confers tolerance to glyphosate, the active ingredient in the Roundup family of agricultural herbicides. MON 88017 was also conventionally bred with MON 810, which produces Cry1Ab protein from *Bacillus thuringiensis* subsp. *kurstaki* strain HD-1, protecting against feed damage from the European corn borer (*Ostrinia nubilalis*). Broilers were fed approximately 55% w/w corn grain in their diet for the first 20 days and approximately 60% w/w corn grain in their diet from day 21 to day 42. The only sources of dietary protein were corn and soybean meal supplemented with methionine and lysine. Feed and water were offered *ad libitum*. Eight treatments (5 male and 5 female pens/treatment with 10 birds/pen) were assigned using a randomized complete block design. The standard randomized block (ANOVA) statistical model was used to analyze the data. Performance parameters (gain, feed intake, and feed efficiency) and carcass measurements were not different (P > 0.05) across treatments. Likewise there were no differences for percentages of moisture, protein, and fat in breast meat and percentages of moisture and fat in thigh meat. Therefore, the diets containing grain of MON 88017 or MON 88017 x MON 810 were nutritionally equivalent to diets containing the conventional control or commercial corn grain when fed to broilers in this 42 day study.

Key Words: Corn, Broilers, Carcass

W40 Comparison of broiler performance when fed diets containing corn with a combination of insect-protected (MON 863, MON 810) and glyphosate-tolerant (NK603) traits, control, and commercial corn. M. L. Taylor^{*1}, B. George², Y. Hyun¹, M. A. Nemeth¹, K. Karunanandaa¹, and G. F. Hartnell¹, ¹Monsanto Company, LLC, St. Louis, MO, ²Colorado Quality Research, Wellington.

Growth performance and carcass measurements were evaluated in a 42-day study in which broilers (Ross x Ross 508) were fed either diets containing genetically modified corn containing transformation events MON 863, NK603, and MON 810 or MON 863 and NK603 (each combination produced by traditional breeding), a genetically similar conventional control, or five commercially available varieties of corn. MON 810 produces Cry1Ab protein isolated from *B. thuringiensis* that provides protection from feeding damage by the European corn borer (*Ostrinia nubilalis*), and MON 863 produces a variant of the wild-type Cry3Bb1 protein isolated from *B. thuringiensis* that protects against corn rootworm (CRW, *Diabrotica sp.*) root feeding damage. NK603 produces the 5-enolpyruvylshikimate-3-phosphate synthase protein from *Agrobacterium sp.* strain CP4 (CP4 EPSPS), which confers tolerance to glyphosate, the active ingredient in the Roundup family of agricultural herbicides. Broilers were fed approximately 55% w/w corn grain in their diet for the first 20 days and approximately 60% w/w corn grain in their diet from day 21 to day 42. Broilers were assigned to eight treatment groups, each consisting of 10 pens (5 male and five female) containing 10 birds/pen, using a randomized complete block design. No differences ($P < 0.05$) were detected among treatment groups for feed intake, gain, feed conversion, adjusted feed conversion, thigh and breast meat composition and most carcass parameters. Breast weight (kg) and wing weight (% of chill weight) were different ($P < 0.05$), however no differences were observed when breast weight and wing weight were expressed on % chill weight basis and weight basis, respectively. The diets containing MON 863 x MON 810 x NK603 or MON 863 x NK603 were nutritionally equivalent to diets containing the control and commercial corn grain when fed to broilers.

Key Words: Corn, Broilers, Carcass

W41 Influence of cereal, heat processing of the cereal, and inclusion of fiber in the diet on performance of broilers. E. Jimenez-Moreno¹, J. M. González-Alvarado², D. G. Valencia¹, R. Lázaro¹, and G. G. Mateos^{*1}, ¹Universidad Politécnica de Madrid, Spain, ²Universidad Autónoma de Tlaxcala, Mexico.

We studied the effects of cereal, heat processing of the cereal (HP), and inclusion of fiber in the diet on productive performance of broilers from 1 to 21 d of age. The experimental design was completely at random with twelve treatments arranged factorially with two cereals (60% corn and 60% rice), two HP (raw and cooked at 90 C during 50 min and then rolled), and three fiber sources (absence, 3% oat hulls, and 3% soybean hulls). Each treatment was replicated three times (12 chicks caged together). Birds and feed consumption were recorded at 0, 4, 8, 14, and 21 d of age. The two control diets were based on soy protein concentrate, soy oil, and either corn or rice, and had 2.45 % and 1.54 % of crude fiber, respectively. In the fiber diets, hulls replaced the same quantity of an inert material. Broilers fed rice had better feed conversion (FC) throughout the trial than broilers fed corn (1.30 vs 1.35 at 21 d of age; $P < 0.05$) but no significant differences were found for daily gain (ADG) (34.1 vs 33.6 g) or feed intake (44.3 vs 45.2 g). From 0 to 4 d of age HP of the cereal reduced ADG (12.3 vs 12.9 g; $P < 0.01$) and impaired FC (1.25 vs 1.16; $P < 0.01$) but the effects disappeared thereafter. It was observed that broilers fed rice wasted more feed than broilers fed corn. The inclusion of hulls in the diet tended to improve FC (1.19 vs 1.24, $P < 0.10$) but the difference disappeared with age. From 0 to 4 d of age a significant interaction between cereal and HP was observed; HP reduced ADG and impaired FC in the corn diet but had opposite effect in the rice diet ($P < 0.01$). We conclude that rice can be used successfully in diets for broilers and that HP of the cereal does not improve performance in corn-based diets. Also, the inclusion of additional fiber improves productive performance in chicks, specially during the first stages of life. Therefore, a minimum of dietary fiber is required in broiler diets.

Key Words: Rice, Heat Processing, Fiber Source

W42 Effect of varied levels of expander cone pressure and dietary energy level on apparent metabolizable energy, nitrogen retention, and turkey poult performance during the period day 7 to 21. K. J. Wilson^{*}, K. R. Cramer, J. S. Moritz, and R. S. Beyer, Department of Animal Science and Industry, Kansas State University, Manhattan.

Three levels of dietary energy consisting of 2557, 2690, and 2800 kcal ME/kg were combined with three levels of expander cone pressure consisting of 0, 200, and 400 lbs/in² (0, 14, and 28 kg/cm²). A conditioning temperature of 180° F (82° C) was used for all treatments. The pelleted feed was re-ground to a fine mash consistency using a hammermill equipped with a 1/8 in. (3.18mm) screen. The turkey poults were obtained from a commercial hatchery and placed on a low dietary energy ration for a 7-day pretest period. The experimental period consisted of day 7 through day 21 post hatching. There were 5 replicate pens containing 5 poults per pen. The poults were housed in Petersime battery brooders located in an environmentally controlled room. The poults were allowed ad libitum access to food and water. The calorie to protein ratio was not held constant in this experiment. Dietary crude protein levels were approximately 28 percent. There was a significant dietary energy effect on nitrogen corrected apparent metabolizable energy (AMEn), nitrogen retention (NR), and feed conversion (FC). The improvement in nitrogen retention as dietary energy increased was most likely due to a protein sparing effect. Feed conversion was improved by increasing the dietary energy level as has been previously demonstrated. Nitrogen retention was also improved by increasing the expander cone pressure level during feed manufacturing. Dietary AMEn tended to improve in the lower energy treatments as the level of cone pressure was increased during feed manufacturing although this was not statistically significant. Overall the results of this experiment indicate that hydrothermal processing of turkey starter diets may improve nutrient utilization and the potential improvement should be accounted for when formulating the diets to avoid any nutrient imbalances.

Key Words: AMEn, Expander Cone Pressure, Nitrogen Retention

W43 Bioavailability of lysine and methionine in a broiler starter diet subjected to varied levels of expander cone pressure. K. J. Wilson^{*}, K. R. Cramer, J. S. Moritz, and R. S. Beyer, Department of Animal Science and Industry, Kansas State University, Manhattan.

Five expander cone pressure levels were used in this experiment including 0, 100, 200, 300, and 400 pounds per square inch (PSI). The conditioning temperature for all treatments was 180 °F (82 °C). An unprocessed mash control was also included in this experiment. The 0-PSI treatment served as the standard feed conditioning/pelleting control. The pelleted feed was re-ground to a fine mash consistency and blended into semi-purified diets. Diets deficient in lysine and methionine were fed to establish standard curves in order to calculate bioavailability. Experiment 1 was conducted to evaluate the effect of increasing expander cone pressure on lysine bioavailability as measured by a broiler chick growth assay. Broiler performance responded favorably to increasing dietary lysine levels supplied either as synthetic lysine or from the test feed ($P = 0.0001$). The relative bioavailability of lysine as measured by the standard curve methodology was unaffected by level of expander cone pressure or by thermal processing. Experiment 2 was conducted to evaluate the effect of increasing expander cone pressure on methionine bioavailability as measured by a broiler chick growth assay. Broiler performance responded favorably to increasing dietary methionine levels supplied either as synthetic methionine or from the test feed ($P = 0.0001$). There were no significant differences in relative methionine bioavailability as measured by the standard curve method. Based on the results of these experiments the bioavailability of lysine and methionine was not affected by the feed processing levels used in these experiments.

Key Words: Bioavailability, Expander Cone Pressure, Lysine

W44 Influence of expander cone pressure on apparent metabolizable energy, nitrogen retention and broiler performance during the starter phase. K. J. Wilson^{*}, J. S. Moritz, K. R. Cramer, and R. S. Beyer, Department of Animal Science and Industry, Kansas State University, Manhattan.

In previous research, subjecting feed to increasing levels of expander cone pressure has resulted in an improvement in the physical quality

of the feed. In turn the improved feed physical quality has led to improvements in broiler performance. While the effects of annular gap expansion on feed physical quality and broiler performance have been shown, at this time, there is very little information concerning the nutritional effects of broiler feed subjected to annular gap expansion. Five expander cone pressure levels were used in this experiment including 0, 100, 200, 300, and 400 pounds per square inch (PSI). The conditioning temperature for all treatments was 180 °F (82 °C). An unprocessed mash control was also included in this experiment. The 0-PSI treatment served as the standard feed conditioning/pelleting control. The pelleted feed was re-ground to a fine mash consistency and blended in to a semi-purified diet at an inclusion level of 40 percent. The evaluation criteria included testing for treatment differences with respect to nitrogen corrected apparent metabolizable energy (AMEn) and nitrogen retention (NR). Broiler performance measurements were also collected during the experiment. Nitrogen retention was significantly improved by subjecting the feed to thermal processing compared to the mash control. There were no significant differences among treatments for AMEn or broiler performance measurements. Based on the results of this experiment, hydrothermal processing of broiler starter diets may improve nitrogen retention. The improvement in nitrogen retention might have important environmental implications due to the relationship between excess nitrogen excretion and ground water pollution.

Key Words: AMEn, Annular Gap Expansion, Nitrogen Retention

W45 Effect of dietary putrescine (1, 4-diaminobutane) on the small intestine protein and deoxyribonucleic acid concentration and morphometric indices in turkey poults challenged with a mixed coccidial infection. S. R. Girdhar*, J. R. Barta, and T. K. Smith, *University of Guelph, Ontario, Canada.*

High cell turnover rates and recovery following mucosal damage to the intestinal epithelium is dependent on sustained supplies of mammalian polyamines. Supplemental dietary putrescine is known to partially overcome the adverse effects produced by anti-nutritional factors. Two experiments were conducted, therefore, to determine the potential for dietary putrescine to promote gastrointestinal tract development and overcome the effects of artificially induced subclinical coccidiosis using a mixed infection. In the first experiment, 450 day-old male poults were fed starter diets supplemented with 0.0 (control), 0.1, 0.2, 0.3 and 0.4% putrescine (30 birds per pen, 3 pens per diet) for 21 days. At the end of each week twelve poults per diet were sampled and intestinal tissue was excised for protein, DNA and morphometric analysis. In the second experiment 160 day-old male poults starter diet supplemented with 0.0 (control), 0.1, 0.2 and 0.3% putrescine (8 birds per pen, 5 pens per diet) for 24 days. At day 14, half the birds were infected with approximately 42,000 sporulated oocysts. Ten birds per diet from each of the unchallenged and challenged groups were sampled on day 6 and day 10 post-infection and tissues were excised and analyzed as described in the previous experiment. In experiment 1 and for the unchallenged group of experiment 2, the feeding of increasing concentrations of dietary putrescine resulted in no significant change in concentrations of protein or DNA. Significant morphometric changes from the feeding of increasing concentrations of putrescine were seen in various segments of the small intestine. In the challenged group of experiment 2, significant dietary effects were seen in protein and DNA concentrations as well as in the morphometric indices. It was concluded that supplementation of starter diets with up to 0.3% putrescine may minimize the adverse effects of coccidial infection.

Key Words: Putrescine, Coccidia, Turkey

W46 Effect of conjugated linoleic acid on antioxidant enzyme activities and lipid peroxidation in the intestine and liver of growing broiler chickens. I. S. Jang*, Y. H. Ko, H. Y. Yang, and C. Y. Lee, *RAIRC, Jinju National University, Jinju, Korea.*

The present study was designed to investigate whether dietary conjugated linoleic acid (CLA) would affect the intestinal and hepatic antioxidant enzyme activity and lipid peroxidation in growing chickens. A total of twenty-four 3-wk-old male broiler chickens were fed one of three isocaloric grower-finisher diets containing 1.5% corn oil (Con), 0.75% corn oil plus 0.75% CLA, or 1.5% CLA for 2 wk beginning from d 22 of

age. The activities of superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), catalase (CAT) and glutathione S transferase (GST) and the concentrations of malondialdehyde (MDA), a marker of lipid peroxidation, in the intestine and liver of these animals were measured at sacrifice. The activities of SOD, GSH-Px, CAT, and GST in the small intestine were not influenced by the level of dietary CLA supplementation. Nor the concentrations of MDA in the mucosa of the proximal and distal segments of small intestine were affected by the dietary CLA supplementation. Hepatic SOD, GSH-Px, and GST activities and the MDA concentration of the 0.75%- and 1.5%-CLA groups also were not different from those of the Con diet group. However, supplementation of 1.5% CLA resulted in an increase in peroxisomal CAT activity and a marked decrease in concentrations of total lipid and non-esterified fatty acids in the liver compared with those of the Con diet group. This suggests that dietary CLA may influence the hepatic antioxidant defense system as well as lipid metabolism in growing chickens.

Key Words: CLA, Antioxidant, Chicken

W47 Effect of early feed restriction on egg quality characteristics of Japanese quail. G. Contreras*, P. C. De la Rosa, C. B. Castro, J. J. Portillo, and F. G. Rios, *FMVZ-Universidad Autonoma de Sinaloa (Mexico, Carr. Culiacan-Mazatlan).*

One experiment was conducted to determine the effect of early feed restriction on egg quality characteristics of Japanese quail. The breeders were restricted in rearing during three weeks (two to five weeks old) at 0, 10, 20, and 30 %. After the feed restriction, the quails were allocated in two batteries with five levels, and each level with four cages. Each cage allocated six females and two males. Birds were fed a diet containing 21 % CP and 2.9 Mcal ME/kg. This size sample was determined by randomized sample with $B = 0.04$ (estimation error) and $\sigma^2 = 0.002$, resulting 20 eggs measurement for treatment each week. The data were analyzed in a complete randomly design, and comparison means by orthogonal polynomials. Egg weight, dense albumin height and width, was not affected ($P > 0.10$). Feed restriction increased ($P < 0.01$) egg width by 1.07 % (26.58 vs. 26.86 mm), egg yolk height by 2.8 % (9.67 vs. 9.94 mm) and egg albumin height by 5.6 % (4.56 vs. 4.8 mm). Feed restriction increased ($P < 0.01$) Haugh Units by 1.7 % (87.97 vs. 89.45), yolk index by 3.2 % (39.38 vs. 40.66), and shape index by 1 % (77.04 vs. 77.8). Shell weight and yolk width were different ($P < 0.01$) between feed restriction levels, 1.99 vs. 1.92, and 1.9 g (10 vs. 20 and 30 %), and 24.35 vs. 24.69 and 24.78 mm (10 vs. 20 and 30 %), respectively. It is concluded, than early feed restriction at 10, 20 and 30 % levels, modifies the egg quality internal characteristics of Japanese quail.

Key Words: Food Deprivation, Egg Quality, Coturnix coturnix japonica

W48 Effect of early feed restriction on productive performance and carcass characteristics of Japanese quail. C. B. Castro, G. Contreras*, F. G. Rios, and J. J. Portillo, *FMVZ - Universidad Autonoma de Sinaloa (Mexico) Carr. Culiacan-Mazatlan.*

This study was conducted to determine the effect of feed restriction (FR) during rearing period (two at five weeks old) on productive performance and carcass characteristics of Japanese quail. The experiment used sixty hundred Japanese quails (408 females and 192 males), two week old with an initial BW of 79.89 ± 8.2 g. Treatments consisted of: 1) Feeding ad libitum (FA); 2) FR 10%; 3) FR 20 %, and 4) FR 30%, during three weeks, and each treatment with three repetitions. Quails were allocated in metallic wire crates (1 x 1 x 0.6 m) and were fed a diet containing 28 % CP and 2.9 Mcal ME/kg (Codoestartina#8482, Purina Mills, Co.). Feed intake was recorder daily and quails were weighted at starter and weekly (five weeks old). Weight gain was calculated by crate. At end of experiment ten quails from each treatment were slaughtered and carcass traits measured. The data body weight and carcass components were analyzed a completed randomized design experiment. BW was similar ($P > 0.10$) with FA and FR 10 % (214.01 vs. 204.8 g) and diminished ($P < 0.05$) by 18 % with FR 30 % (214.01 vs. 175.16 g). FR 10% and FR 20% shown similar values (204.8 vs. 200.3 g). Carcass weight was similar with FA and FR 10% (128.16 vs. 119.26 g), but decreased ($P < 0.05$) by 10.8 % with FR 20% (128.16 vs. 114.36 g), and 26 % with FR 30% (128.16 vs. 94.87 g). Total lean weight was diminished ($P < 0.05$) by 29 % with FR 30% (77.07 vs. 54.48 g). Total fat weight was decreased ($P < 0.05$) by FR. Total bone weight was no affected ($P > 0.10$) by treatments (33.31 g). Its concluded than early

feed restriction of 10 % maintain the productive response and carcass characteristics of Japanese quail.

Key Words: Food Deprivation, Carcass Composition, Coturnix Coturnix Japonica

W49 Adding thymol to a broiler diet influences in vitro cecal fermentation and in vivo growth performances. A. Piva*, E. Grilli, G. Casadei, and G. Biagi, *DIMORFIPA - University of Bologna, Ozzano Emilia-Italy.*

Thymol and other essential oils have antimicrobial properties and may be considered among the alternatives to antibiotic growth promoters. We evaluated the effect of thymol in broiler in vitro cecal fermentations and broiler growth performances. In the in vitro study, broiler cecal inoculum was incubated for 24h in graduated syringes and vessels containing a standard predigested diet without or with thymol at 75, 150, 300, 600, 900, or 1200 ppm. Compared to control, total gas production was reduced by thymol at every concentration ($P < 0.01$), being almost completely inhibited by thymol at 900 and 1200 ppm. The rate of gas production was reduced only when thymol was used at 900 and 1200 ppm ($P < 0.01$). Ammonia concentration was lower than in control vessels ($P < 0.01$) at 4 h when thymol was used at 1200 ppm (-27%) and at 8 h with thymol at 600 (-20%), 900 (-25%), and 1200 ppm (-21%); at 24 h, thymol at 150 (+29%), 300 (+28%), and 900 ppm (+33%) resulted in higher ammonia than control ($P < 0.01$). In the vivo trial, 2160 female broilers (Ross 508) were divided immediately after birth into 4 groups (9 cages of 60 birds per group) and received a commercial diet with or without (control) the addition of thymol at 300, 600, or 900 ppm. Birds were fed ad libitum until the slaughtering age (39 d). Compared to control, the final live weight was higher when thymol was fed at 600 ppm (+2%) but lower when thymol was added at 300 (-5%) and 900 ppm (-2%; $P < 0.01$). Feed efficiency was lower in birds receiving thymol at 300 (-6%) and 900 ppm (-2%; $P < 0.01$) than in control birds. Daily feed intake and dressing out percentage were not influenced by thymol dose. Thymol influenced in vitro cecal fermentation, reducing total gas production and controlling proteolysis in the first 8 h of fermentation. Thymol at 600 ppm enhanced birds growth. Nevertheless, thymol had a negative effect on broiler growth and feed to gain ratio when used at 300 and 900 ppm.

Key Words: Broiler, Thymol, Essential Oils

W50 Palm fatty acid distillate calcium soap as vegetable fat source for broiler diets. J. Sánchez¹, A. Gutiérrez², J. I. Fernández³, D. Menoyo⁴, and P. Medel*¹, ¹*Imasde Agropecuaria, S.L., Spain*, ²*Nutreco PRRC, Spain*, ³*Norel, S.A., Spain*, ⁴*Universidad Complutense de Madrid, Spain.*

A total of 1,170 Ross broilers (50 % male and 50 % female) were used to determine the effect of inclusion of palm fatty acid distillate (PFAD) calcium soap in the diet on performance and carcass quality. There were three treatments based on fat source: T1) control diet including soya oil (4.8 %), T2) PFAD calcium soap (5.1 %) and T3) PFAD calcium soap + glycerol (5.1 %). Treatments were applied to both starter (2,975 kcal AME/kg and 1.32 % lys, from 0 to 21 d) and grower (3,050 kcal AME/kg and 1.18 % lys, from 22 to 42 d) diets, which were calculated to be isonutritive among treatments. Each treatment was randomly assigned to 10 pens of 39 broilers each. From 0 to 21 d, control chicks grew 3 % more and showed better feed conversion than animals on T2 and T3 (38.5, 36.8 and 37.9 g/d and 1.33, 1.39 and 1.39 g/g for T1 to T3, respectively; $P < 0.05$), but dietary treatment did not affect performance between 22 to 42 d. For the overall period, chicks on T3 ate 2.5 % more than chicks on T1 and T2 (110.2, 110.1 and 112.9 g/d for T1 to T3, respectively; $P < 0.05$), but broilers fed soya oil showed 3 % better feed conversion (1.72, 1.76 and 1.77 g/g for T1 to T3, respectively, $P < 0.05$). Animals fed T2 had lower BW and carcass weight than the others (2,688, 2,763 and 2,740 g and 2,165, 2,227 and 2,212 g for T1 to T3, respectively; $P < 0.05$) but carcass yield did not differ among treatments (80.6, 80.6 and 80.7 %, for T1 to T3, respectively; $P > 0.05$). It is concluded that i) PFAD calcium soap can be used as an alternative to soya oil, and ii) glycerol addition improves the feeding value of the PFAD calcium soap for broilers.

Key Words: PFAD Calcium Soap, Vegetable Fat Sources, Broilers

W51 Use of palm fatty acid distillate calcium soap as a vegetable fat source for broiler diets. M. I. Gracia*¹, A. Flores², J. I. Fernández³, J. Peinado¹, and C. López-Bote⁴, ¹*Imasde Agropecuaria, S.L., Spain*, ²*Nutreco PRRC, Spain*, ³*Norel, S.A., Spain*, ⁴*Universidad Complutense de Madrid, Spain.*

A total of 1,170 Ross broilers (50 % male and 50 % female) were used to determine the effect of inclusion of palm fatty acid distillate (PFAD) calcium soap on performance and carcass quality. From 21 to 42 d of age there were three treatments (T1 to T3) depending on the level of substitution of 4.8 % soya oil by PFAD calcium soap in fat basis: 0, 50 and 100 %, respectively. All the birds were fed with a common starter diet from 0 to 21 d (2,975 kcal AME/kg and 1.32 % lys) and the experimental treatments were applied in the grower period under isoenergetic basis (3,200 kcal AME/kg and 1.18 % lys). Each treatment was randomly assigned to 10 pens of 39 broilers each. At 21 d BW was similar for all groups (851 g; $P > 0.05$). From 22 to 42 d, chicks on T1 (soya oil) ate 4 % less than birds on T2 and T3 (162.4, 168.7 and 168.7 g/d for T1 to T3, respectively; $P < 0.05$) and grew less than T2 animals, showing birds on T3 intermediate results (87.5, 90.2 and 88.8 g/d for T1 to T3, respectively; $P < 0.05$). However, birds on T3 showed the worst feed conversion (1.86, 1.88 and 1.91 g/g for T1 to T3, respectively; $P < 0.05$). Consequently, animals on T2 showed higher BW and carcass weight (2,709, 2,756 and 2,724 g and 2,183, 2,227 and 2,194 g for T1 to T3, respectively; $P < 0.05$). However, carcass yield did not differ among treatments (80.8, 80.6 and 80.5 %, for T1 to T3 respectively; $P > 0.05$). It is concluded that PFAD calcium soap could partially or totally replace the soya oil with limited effects on performance.

Key Words: PFAD Calcium Soap, Vegetable Fat Sources, Broilers

W52 Processed Mucuna (*Mucuna pruriens*) seeds for broiler production. E. A. Iyayi* and M. Rodehutsord, *Institut für Ernährungswissenschaften, Halle, Germany.*

The ability of Mucuna (an unconventional plant protein source) to replace the conventional soy bean meal was the subject of this study since Mucuna seeds have recently been receiving attention as a potential feed for non-ruminants and food for man. Mucuna seeds were processed by dry heating (roasting) and milled. The meal was used to replace soy bean meal in a commercial broiler diet such that the diets had 0, 6, 12 and 18 g/kg of the roasted mucuna seed meal (RMSM). These levels corresponded to 0, 33.3, 66.7 and 100 % replacement of soy bean meal in the diets. Forty (40) one-week old broiler chicks were randomly allocated to each of the diets after their weights were equalized. Each diet had 5 replicates of 8 birds each. Incorporation of 6 g/kg RMSM in place of soy bean meal gave similar feed intake, body weight gain and efficiency of feed utilization in birds as the soy bean meal diet. But above this level (i.e. at 12 and 18 g/kg) these parameters were significantly ($P < 0.05$) depressed. At the 6 g/kg inclusion level, the weights of air sacs, small and large intestines and ceaca were reduced significantly ($P < 0.05$) while those of liver and spleen were significantly ($P < 0.05$) increased. Histological examination of the organs showed that the higher inclusion levels of RMSM caused various degenerative syndromes in the organs possibly as a result of the disruptive properties of the antinutritional factors in Mucuna when fed at higher levels. Results of the study showed that Mucuna when roasted can replace only a third of the amount of soybean meal in broiler diet. Above this level, Mucuna exerts a negative effect on the performance of the birds.

Key Words: Mucuna, Broilers, Performance

W53 Fat quality assessment of feed and pet food-grade poultry by-product meals. W. A. Dozier, III*¹, N. M. Dale², and A. F. Giesen³, ¹*USDA-ARS Poultry Research Unit, Mississippi State, MO*, ²*The University of Georgia, Athens*, ³*Novus International, Inc, St. Louis, MO.*

Poultry-by product meal (PBM) has long been a valuable protein source for poultry feeds. However, in recent years pet-food manufacturers have mandated to renderers that PBM be manufactured without "lower quality" by-product fractions, such as feathers, heads and paws. This has resulted in a higher protein "pet food-grade" product over conventional feed-grade PBM. It is presumed that the current "feed-grade" PBM is of lower quality and more variable, nutrient value, since the highest quality offal components have been diverted to pet food meals. In addition,

information is limited on the variation of fat quality between pet food and feed-grade PBM sources.

Forty-six PBM samples (25 = feed grade and 21 = pet food grade) were collected from commercial feed mills located in DE, GA, NC, SC, and VA during the winter and summer months of 2003. Sub-samples were analyzed for Initial Peroxide (IPV) (meq/kg), 4 and 20-hr active oxygen method peroxides (AOM) and Ethoxyquin (ppm). Average fat quality measurements for the Pet Food and Feed Grade PBM by season are shown below with their respective STD. The seasonal effect of high temperatures was apparent with extent of fat oxidation, regardless of PBM source. In those samples obtained in the winter, which had similar antioxidant content, the feed-grade samples were characterized by poorer fat stability. In the samples received in summer, when higher temperatures would be expected to negatively affect stability, the residual antioxidant present in the pet food meals was less than half that found in the feed-grade samples (64 vs. 164 ppm). All indicators of fat stability showed increased potential for rancidity in these pet food-grade samples, confirming that the highly unsaturated poultry fat in PBM requires adequate concentrations of antioxidant protection, even when meals are derived from prime offal components.

PBM	Season	IPV (meq/kg)	4-hr AOM (meq/kg)	20-hr AOM (meq/kg)	ETH (ppm)
Pet Food					
Grade	Winter	3.3±8.1	2.1±3.7	1.2±1.1	138.8±142.9
	Summer	123.9±118.1	68.4±62.6	59.5±55.9	63.8±62.2
Feed					
Grade	Winter	72.8±118.8	3.0±2.3	3.2±1.9	115.9±106.8
	Summer	20.4±42.6	2.57±5.1	7.4±9.1	164.0±134.8

Key Words: Poultry By-Product Meal, Pet-Food, Feed

W54 Influence of boiling, Biogen or spices mixture to Mangrove leaves on performance of egg type pullets. A. Eldeek* and M. Al-Harhi, *King Abdulaziz University, Faculty of Meteorology Environmental and Arid Land Agriculture, Jeddah, Saudi Arabia.*

450 Lohmman Egg strain female chicks were randomly distributed to 15 dietary treatments each contained 3 replicates of 10 pullets and 3 levels of Mangrove leaves (ML) (0, 5 and 10%), which was included as raw or boiled for 15 minutes. Therefore, there were 5 main isocaloric and isonitrogenous experimental diets. Each diet was fed with or without Biogen or a spice mixture (SM) (1:1:1) of cardamom, cumin, hot and black pepper supplementation. ML had no adverse effect on pullets growth, feed consumption (FC), feed conversion ratio (FCR) and mortality rate during 8-20 wks of age. However, including 10% of ML in pullet diets significantly increased FC of ML and increased water consumption significantly. Boiling treatment increased significantly growth and improved FCR of pullets by 3% and did not significantly affect FC. Boiling treatment significantly increased water consumption by 11.9%. Biogen or SM had no enhancing effect on growth and FC of pullets; however FCR and water consumption tended to improve insignificantly due to addition of Biogen and SM with spices being more effective. ML at 5 and 10% resulted in 16.7 and 31% reduction in laying rate, egg mass and FCR, respectively. The improvements in egg laying rate due to Biogen and SM equaled 11.7, 11.5, 19 and 17.4% for groups fed diet containing 5 and 10% ML, respectively with egg mass and FCR following a similar trend. SM increased egg weight significantly compared to the control and Biogen groups. SM significantly decreased weight and percentage of ovary and only weight of oviduct, while increased the weight and percentage of spleen. ML had no adverse effect on interior quality of eggs stored for 8 weeks in the fridge. In conclusion, ML could be included in the pullet and laying diets at 5% when supplemented with SM without adversely affecting performances.

Key Words: Mangrove Leaves, Feed Additives, Spices

W55 Effects of Hippophae Rhomnoides fruit extract supplementation on egg quality and performance of layers in the wheat-based diet. F. Liu*, J. Fu, and Z. Niu, *North-west sci-tech university of agriculture & forestry, Yangling, China.*

The objective of this experiment was to evaluate the effect of a natural pigment additive (AY) extracted from Hippophae Rhomnoides fruits on egg quality and performance of laying hens in the wheat-based diet. 480 Lohmann commercial layers at 53 weeks of age were divided into five groups, each of three replicates. The diets were based wheat-soybean meal supplemented with 0.0%, 0.5%, 1.0%, 2.0%, 4.0% resp.. The birds were reared in cages for 21 days. The results showed that: (1) The RFC value was significantly improved when AY in diet was more than 1.0% ($p < 0.05$), and achieved 6.6 at AY 4.0%. L-value was decreased with increase in level of AY ($p < 0.01$), but both a-value (red) and b-value (yellow) were significantly increased ($p < 0.01$). (2) The carotenoid content in egg yolk was linearly increased with the level of AY in the diets ($p < 0.01$), but the concentration of cholesterol was significantly reduced ($p < 0.05$). (3) There were no significant influences of addition of AY on laying rate, egg size, egg mass, feed intake, and feed conversion of laying hens in the wheat-based diet ($p > 0.05$).

Key Words: Natural Pigment Additive, Egg Quality, Laying Hen

W56 The effects of inclusion of a fermented fish by product meal in Guinea fowl (*Numida meleagris*) diets on performance and carcass quality. M. Argüelles*, H. L. Santiago, and A. A. Rodríguez, *Department of Animal Science, University of Puerto Rico - Mayaguez Campus, Mayaguez.*

Guinea fowl (*Numida meleagris*) is a poultry species suitable for use in meat production to expand and diversify the local poultry industry due to its consumer acceptance, resistance to common poultry diseases, and tolerance to poor management conditions. However, the poor feed conversion of this species increases feed costs and limits production. To reduce feed costs it is imperative to find feedstuffs of low cost but with adequate nutritional value. The use of a fermented fish by-product meal (FFBPM) as a protein source in guinea diets could satisfy these criteria and reduce feed costs. The objective of this study was to evaluate the effects of the inclusion of a FFBPM in guinea diets on bird performance and carcass quality. Treatments consisted of FFBPM inclusion at 0 (control), 5, and 10% in each of the starter, grower, and finisher rations. Feed and birds were weighed at 0, 35, 63, and 84 d to determine body weight (BW) and feed conversion (FC). At 84 d, 90 birds were processed to evaluate carcass composition and to determine yields of carcass and major cuts. Their fasted live BW, plucked and dressed carcass weights were recorded and yields calculated. No differences in BW were observed among treatments at 0, 63, and 84 d. At 35 d BW was lower ($P < .05$) in birds with a 10% FFBPM inclusion. FC was also higher with 10% FFBPM and lower in control birds, while those receiving 5% FFBPM did not differ from the other treatments. Birds fed 10% FFBPM showed lower ($P < .05$) live, plucked, and dressed weights than control and 5% FFBPM birds. No differences ($P = .05$) among treatments were observed in yields of dressed carcass, major cuts, and the proportion of flesh, skin, and bone. However, the percentage of abdominal fats was lower ($P < .05$) in birds fed a 10% FFBPM when compared to the control and 5% FFBPM level. The results of this study indicate that the inclusion of up to 5% FFBPM in guinea diets has no detrimental effect on bird performance and carcass quality. Thus, FFBPM could be a valuable feed ingredient to supply part of the dietary protein requirements of guinea fowl.

Key Words: Guinea Fowl, Growth, Fermented Fish

W57 Inclusion of coconut meal in broiler initial diets. S. Bastos, M. de F. Fuentes*, and E. Freitas, *Universidade Federal do Ceará Departamento de Zootecnia, Fortaleza, CE, Brazil.*

Coconut meal (CM) is considered an alternative to soybean meal as a protein ingredient for animal feed. The objective of this work was to evaluate the performance of broiler in the initial period (7 to 21 days of age) fed diets containing different levels of CM. 576 broilers males from a commercial line with seven days of age and similar body weight were distributed at random among six treatments with eight replicates of twelve birds each. Treatments consisted of six diets containing 0; 3.5;

7.0; 10.5; 14.0 and 17.5% of CM. Diets were based on corn and soybean meal and were isoproteic (21% CP) and isocaloric (2950 kcalME/kg). Regression analysis excluding diet with 0% of CM showed that feed intake ($y = 1047 - 0.004x$; $R^2 = 24.67$) and weight gain ($y = 684.89 - 7.20x$; $R^2 = 68.57$) decreased linearly as CM increased in diets. However for feed conversion there was a quadratic effect ($y = 1.66 - 0.02x + 0.002x^2$; $R^2 = 53.75$) and 5% was the maximum level of CM inclusion according to this variable. In relation to diet without CM, Dunnett's test (5%) indicated that all levels of CM used reduced weight gain and feed conversion. These results can be attributed in part to the high fiber content of CM, which lowered feed consumption and nutrient absorption by birds. It can be concluded that CM can be included in levels up to 5% in diets for broilers with 7 to 21 days of age.

Key Words: Coconut Meal, Weight Gain, Feed Intake

W58 Pea, Faba beans and Lupin as an alternative protein source in broiler diet. M. Moschini¹, F. Masoero¹, A. Prandini¹, M. Morlacchini², G. Fusconi², and G. Piva¹, ¹Università Cattolica del Sacro Cuore, del Sacro Cuore Via Emilia Parmense, Piacenza, Italy, ²CERZOO, San Bonico, Piacenza, Italy.

The problems of meat and bone meal and transgenic feeds poses a challenge to animal nutritionist in Europe. The challenge is to find home-grown protein-rich feedstuffs, making sure no antinutritional factors are present that could interfere in the animals' performance. The raw Pea (*Pisum sativum*) (RP), raw Faba beans (*Vicia faba*, variety minor) (RFb) and raw Lupin (*Lupinus albus*, variety multitalia) (RL) were evaluated as an alternative protein sources in broiler diets. 630 Ross 1 d-old male Marek vaccinated chicks were randomly assigned to seven dietary treatments (5 pens per treatment/18 birds per pen). Chicks were floor housed, ad libitum fed isocaloric and isonitrogenous diets and had free access to water. Artificial light was provided 10 h/d. The bulk of the base diet (control diet) was corn (48.7%, 56.6% and 57%), solvent-extracted soybean meal (42.8%, 37.3% and 33.4%), corn oil (4.4%, 5.2% and 6.3%), plus synthetic amino acids, minerals, trace minerals and vitamins, respectively for the 1-10 d-old, 11-28 d-old and 29 to 42 d-old growing periods. The RP, RFb and RL entered the diets in substitution of the soybean and corn according to the cost optimization in diet formulation (P100, Fb100 and L100, respectively for RP, RFb and RL) and at the half of the optimized quantity (P50, Fb50 and L50, respectively for RP, RFb and RL). The amount used as fed basis were: P100: 350 g/kg for all diets; Fb100: 480 g/kg (1-10 d-old) and 500 g/kg (11-42 d-old); L100: 360 g/kg (1-10 d-old) and 300 g/kg (11-42 d-old). At the end of the trial (42d) the percentage yields of breast meat and leg quarters were measured in one animal for each experimental unit for all treatments. Bird mortality was recorded daily and dead birds were removed and weight was recorded. The pen average daily intake (ADI) and average daily gain (ADG) were calculated and adjusted feed to gain ration (F:G) was obtained. The ADG, ADI, F:G, breast yield and leg quarter were not statistically affected by the treatment diets. Data suggest partial substitution of soybean with RP, RFb or RL had no effect on animal performance and could represent an alternative valuable protein source in broiler diet formulation.

Key Words: Alternative, Protein Source, Poultry

W59 Influence of a paprika extract supplementaion on egg yolk color and performance of laying hens. Z. Niu*, J. Fu, and F. Liu, College of Animal Science & Technology, Northwest Sci-Tech University of Agriculture & Forestry, Yangling, China.

This experiment was conducted to evaluate the effects of AR(pigment additive extracted from paprika) on egg yolk color, and laying performance of hens in a wheat-based diet. 480 Lohmann commercial layers at 53 weeks of age were divided into 5 groups, each of 6 replicates, to feed for 21 days. The experimental diets were based on wheat-soybean meal supplemented with 0%, 0.1%, 0.2%, 0.4%, 0.8% AR resp.. The results showed that: (1) AR caused an increase in egg yolk pigmentation. RFC

achieved 9.9 when added 0.8% AR in diet. (2) with an increase in adding AR from 0 to 0.8%, a-value (red) increased quickly ($p < 0.01$), L-value decreased largely ($p < 0.05$), and b-value reduced slightly ($p > 0.05$). (3) The total carotenoids deposition in egg yolk showed a proportionally greater increase with increasing AR level in diet. There were no significant influence of AR supplementation on laying rate, egg size, and feed conversion of hens.

Key Words: Paprika Pigment, Egg Yolk Color, Laying Hen

W60 Fermenting sludge from a broiler processing plant: Effect of inoculation with lactic acid-producing bacteria. S. Pagán*, R. Sanabria, A. A. Rodríguez, and M. Pagán*, University of Puerto Rico - Mayaguez Campus, Department of Animal Science, Mayaguez.

The effects of adding a commercial lactic acid-producing bacterial inoculant (LAPBI) on the fermentation characteristics of sludge from a broiler processing plant (SBPP) was determined. The SBPP was mixed with 20% (w/w) cane molasses and assigned to two treatments: no additive (control) and LAPBI applied at 106 cfu/g of fresh material. Mixtures were placed in lab micro-silos (1.2 kg capacity) under anaerobic conditions and maintained at room temperature (28-30°C). Three samples per treatment were collected after 0, 4, 8, 12, 15 and, 21 d and analyzed for pH, chemical composition, microbial succession and fermentation products. Data was analyzed as a completely randomized design with a 2 (with or without LAPBI) x 6 (fermentation periods) factorial arrangement of treatments. The Bonferroni t-test was used for mean separation. Final pH of SBPP fermented with or without LAPBI was similar ($P < .05$, 3.8 vs 3.87) after 21 d of fermentation. For both treatments, coliforms and lactic acid producing bacteria populations were similar ($P < .05$) at the end of the fermentation process, but yeast and molds were higher ($P < .05$) in SBPP with LAPBI. Chemical composition of the final product indicates no differences between treatments. Lactic and acetic acid content were higher ($P < .05$) in non inoculated sludge compared to sludge with LAPBI. However, for both treatments values for lactic acid at the end of fermentation were indicative of good quality silage. In summary, utilization of LAPBI may not be necessary to ferment SBPP with cane molasses to obtain a stable product.

Key Words: Lactic Acid-Producing Bacteria, Sludge, Anaerobic Fermentation

W61 Assessment of essential oils as potential substitutes for dietary antibiotics. W. Si¹, J. Gong¹, R. Cao¹, T. Zhou¹, H. Yu¹, C. Poppe², R. Johnson², and W. Du³, ¹Food Research Program, Agriculture and Agri-Food Canada, Guelph, Ontario, ²Laboratory for Foodborne Zoonoses, Health Canada, Guelph, Ontario, ³Ontario Ministry of Agriculture and Food, Guelph, Canada.

The concerns over the use of antibiotics in-feed and their contribution to the development of antibiotic resistance have stimulated research in developing antibiotic-replacement. Some essential oils have demonstrated strong antimicrobial activity. In this study, *Salmonella typhimurium* DT104, *E. coli* O157:H7 and K88 were used as target pathogens to evaluate the effect of essential oils. Among 66 essential oils and related chemicals, 14 exhibited more than 80% inhibition against both pathogens. Minimum Inhibitory Concentrations were determined for 9 essential oils/compounds. Cinnamon, clove, geraniol, and thymol were most potent against both pathogens. The effect of the essential oils/compounds on the isolates of beneficial bacteria, such as *Lactobacilli*, was also examined. No significant inhibition was observed. The influence of selected essential oils on the normal gut flora and their potency to inhibit the target pathogens in the presence of digesta are under investigation. Our in vitro assessment suggests the potential of essential oils and related chemicals as the substitutes for dietary antibiotics although in vivo studies are required to verify our in vitro observations

Key Words: Essential Oil, *E. Coli*, *S. Typhimurium*

Nonruminant Nutrition: Feedstuffs & Methodology

W62 Comparison of classical and marker method, using three different markers and two analytical techniques, for the measurement of apparent digestibility in swine. L. L. Oetting*¹, A. L. Abdalla¹, J. D. F. Gomes², A. R. A. Nogueira³, and C. E. Utiyama¹, ¹Universidade de São Paulo, Piracicaba-SP, Brazil, ²Universidade de São Paulo, Pirassununga-SP, Brazil, ³Empresa Brasileira de Pesquisa Agropecuária-Centro de Pesquisa de Pecuária do Sudeste, Sao Carlos-SP.

Use of markers for the measurement of digestibility is a less intensive labor method than total fecal collection. Little is known about the use of rare earth as dietary markers in digestibility assays with swine. The aim of this work was (1) to compare the digestibility coefficient obtained by the classical method (CM) with the marker method (MM), using three dietary markers simultaneously: chromium (Cr), lanthanum (La) and ytterbium (Yb), and (2) to compare two analytical techniques (Inductively Coupled Plasma Atomic Emission Spectrometry - ICP-OES, and Energy Dispersive X-Ray Fluorescence - ED-XRF) of marker analysis. Twelve finishing gilts were housed in individual metabolism crates. The experimental diet consisted of a corn-soybean meal diet added with 0.3% of Cr and 60 mg/kg of La and Yb. Comparison between the digestibility coefficients (DC) of gross energy (GE), dry matter (DM) and crude protein (CP) are shown below. There were differences between analytical techniques in determination of Cr and La. Comparison between the MM with the CM showed that Cr+ICP-OES and La+ED-XRF provided similar results ($P>0.01$) for energy and protein digestibility coefficients. The differences between the two methods can be explained by the low percentage of recovery of the markers in feces (80.97, 66.38, 57.43, 58.22, 82.32 and 46.19% for Cr+ICP, La+ICP, Yb+ICP, Cr+ED, La+ED and Yb+ED, respectively). It can be suggested that La+ED-XRF can be an alternative marker for Cr in digestibility studies with swine and it can be used at lower concentrations without affecting accuracy.

(%)	Classical method	Cr+ICP -OES	La+ICP -OES	Yb+ICP -OES	Cr+ED -XRF	La+ED -XRF	Yb+ED -XRF	SE
GE	87.27	87.07	83.77	80.91	81.65	87.01	84.36	1.09
DM	90.55	86.43	82.98	79.97	80.75	86.37	83.58	1.02
CP	85.58	85.36	81.61	78.38	79.24	85.30	82.29	1.27

Key Words: Apparent Digestibility, Swine, Rare Earth

W63 Comparison of the single dose and withdrawal method for measuring the rate of passage of swine basal diets using multiple markers and alternative analytical techniques. L. L. Oetting*¹, A. L. Abdalla², J. D. F. Gomes³, A. R. A. Nogueira⁴, and C. E. Utiyama¹, ¹Escola Superior de Agricultura "Luiz de Queiroz" da Universidade de So Paulo, Piracicaba-SP, Brazil, ²Centro de Energia Nuclear na Agricultura da Universidade de So Paulo, Piracicaba-SP, Brazil, ³Faculdade de Zootecnia e Engenharia de Alimentos da Universidade de So Paulo, Pirassununga-SP, Brazil, ⁴Empresa Brasileira de Pesquisa Agropecuária - Centro de Pesquisa de Pecuária do Sudeste, Sao Carlos-SP, Brazil.

There are few studies on the determination of the rate of passage of diets in swine. Multiple markers can be used simultaneously to determine different rates of passage in the same animal. Rare earth elements offer some advantages in terms of cost, quantitative analyses and total recovery in faeces. Four finishing gilts were used to determine the rate of passage by single dose and withdrawal method of a basal diet (corn-soybean meal) using the combination of the three markers (chromium, lanthanum and ytterbium) and two analytical techniques: Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-OES) and Energy Dispersive X-Ray Fluorescence (ED-XRF). The Cr was added directly to the diet, but the La and Yb were primarily incorporated to the maize. In the withdrawal method, the markers were administered in diet for 5 d and then were withdrawn. The concentration of markers in faeces was transformed to their natural logarithmic values and simple regression analysis was performed to establish the relationship between the natural log of marker concentration with time. The slopes of the regression lines ("b"), which represents the rate of marker disappearance, were compared for both methods and each marker by Tukey's test. There were no statistical differences between the two methods, with exception for the treatment Cr+ICP-OES. The mean of the slopes of the regression lines for Cr+ICP-OES, Cr+ED-XRF, La+ICP-OES,

La+ED-XRF, Yb+ICP-OES and Yb+ED-XRF was 0.087, 0.086, 0.021, 0.049, 0.032 and 0.046 (SE=0.015), respectively. The difference in the rate of passage found for La and Yb, in relation to Cr, was, probably, a result of the lower rate of passage of the maize in relation to the diet.

Key Words: Swine, Rate of Passage, Rare Earth

W64 International Life Sciences Institute crop composition database: documenting natural variability in crop composition. W. P. Ridley*¹, R. D. Shillito², and L. Kurtyka³, ¹Monsanto Company, St. Louis, MO, ²Bayer CropScience, Research Triangle Park, NC, ³International Life Sciences Institute, Washington DC.

An understanding of the natural variability in nutrient composition of maize and soybeans is an important consideration in the development of diets that promote the healthy growth of swine, poultry, beef cattle and other livestock animals. Most existing publicly available crop composition data sources have relied on data that were 20 or more years old. In many cases the methods used for the generation of these data were not known or their performance parameters were not available. In May 2003, the International Life Sciences Institute (ILSI) released Version 1.0 of an online comprehensive crop composition database (www.cropcomposition.org) that provides up-to-date information on the natural variability in the composition of conventional crops. The database is a compilation of over 53,000 data points on 102 nutritionally important analytes for maize and soybean samples obtained from controlled field trials in multiple worldwide locations between 1995 and 2001. All data can be traced back to their source and every data point is identified with its analytical method. The database is searchable, via a web-browser-based interface, on a number of attributes including analyte, matrix, year of harvest and field location. Information about the database has been shared with regulators, scientific/academic institutions, FAO, OECD, other ILSI task forces, and the US National Academy of Sciences. The ILSI Task Force responsible for the database plans to release Version 2.0 in the spring of 2004 that will contain over 70,000 data points and include data for cottonseed plus additional data sets for maize and soybeans.

Key Words: Crop Composition, Nutrients, Crop Composition Database

W65 Comparison of corn grain from biotech and non-biotech counterparts for grow-finish pig performance. H. H. Stein*¹, T. Sauber², D. Rice², M. Hinds², D. Peters¹, G. Dana², and P. Hunst³, ¹South Dakota State University, Brookings, ²Pioneer Hi-Bred International Inc., Johnston, IA, ³Dow AgroSciences LLC, Zionsville, IN.

An experiment with 96 growing pigs (initial BW 23.5 kg) was conducted with the objective of testing the hypothesis that the inclusion of a genetically modified corn in diets for swine does not compromise pig performance or carcass quality. Four corn sources were used in the experiment. Corn 1 was bin-run obtained from the SDSU feed mill. The remaining three corns were obtained from Pioneer Hi-Bred International Inc. Corn 2 was grain produced from hybrid Pioneer[®] brand 33J56, corn 3 was grain produced from hybrid Pioneer[®] brand 33P66, while corn 4 was grain produced from hybrid Pioneer[®] brand 33P66 containing the TC1507 event. TC1507 is an event that contains the Cry1F gene from *Bacillus thuringiensis* var. azawai. This gene encodes the Cry1F protein that has been shown to have insecticidal activity towards several insects including European corn borer and black cutworm. The trade name for this corn is Herculex#8482 I. This trait was developed through collaboration between Pioneer Hi-Bred International, Inc. and Dow Agrosciences LLC. Diets based on each of the four corns were formulated using a single source of soybean meal. Pigs were assigned to four different treatment groups at approximately 23.5 kg based on ancestry, gender, and BW. There were three pigs per pen and eight replicate pens per treatment. A three phase feeding program was used with diets containing 1.0, 0.8, and 0.63% LYS within each phase. At 120 kg BW, pigs were harvested and carcass measurements recorded. During the first phase of the experiment, pigs fed the diet based on corn 3 had greater ($P \#8804 0.05$) ADFI than pigs fed the other corns, however, there were no treatment differences in ADG or G:F. During the second and third phases and overall, no differences in ADG, ADFI, or G:F were observed. Likewise no differences in dressing percentage, 10th rib back fat, loin-eye area, fat

free lean, or lean meat percentage were detected. It is concluded that no negative effects on pig performance, dressing percentage, or carcass quality are associated with the use of corn produced from seed containing the Herculex#8482 I trait.

Key Words: Genetically Modified Corn, Performance, Pigs

W66 Digestive fate of a *gdhA* gene from a genetically modified corn fed to growing pigs. X. Qiu*¹, G. A. Appgar¹, K. E. Griswold², J. M. Beagle¹, M. P. Martin¹, K. L. Jones¹, M. J. Iqbal¹, and D. A. Lightfoot¹, ¹*Southern Illinois University, Carbondale*, ²*Penn State University Extension, Lancaster*.

Eight female PIC pigs (initial BW, 47.5 ± 1.8 kg) with an additional all-time negative control pig were utilized in a two period switchback design to evaluate the digestive fate of a transgenic corn. Pigs were fed diets comprised primarily of a genetically altered corn or a non-altered isogenic corn grown in the same locations. The genetically altered corn (*gdhA*+) contained a glutamate dehydrogenase gene isolated from *Escherichia coli*. Pigs were surgically fitted with steered ileo-cecal valve cannulas for collection of ileal digesta. Pigs were limit fed at 8% of metabolic body weight (BW^{0.75}), in two equal feedings at 0600 and 1800 each day throughout the experiment. The study consisted of two 15-d periods. Each period was comprised of a 7-d acclimation period, a 3-d total collection of feces and urine, and two 12-h ileal collections separated by a 3-d adjustment period to assure adequate hydration. Samples of corn, diets, ileal digesta and feces were frozen immediately upon collection. Total genomic DNA was extracted, underwent PCR, and was visualized using agarose gel electrophoresis. Primers were designed to yield a 456 bp PCR product expanding from a rice-ubiquitin gene to the *gdhA* gene within the transgenic cassette. These primers were selected to eliminate the potential of replicating the *gdhA* gene from resident gastrointestinal tract bacteria. While the PCR product was detected from *gdhA*+ corn, *gdhA*+ diets, and even a mixture of the two corn sources containing only 1% *gdhA*+ corn, it was not detected from *gdhA*- corn or diets, or from ileal digesta or feces of any pigs, no matter if they were fed *gdhA*+ or *gdhA*- diets. In conclusion, the recombinant DNA fragment from *gdhA*+ corn appears to be digested and is not detected by regular PCR analysis.

Key Words: *gdhA* Gene, Genetically Modified Corn, Pigs

W67 Herbicide-tolerant rice versus conventional rice in diets for growing-finishing pigs. G. L. Cromwell*¹, B. J. Henry², and D. W. Fletcher³, ¹*University of Kentucky, Lexington*, ²*Bayer CropScience LP, Research Triangle Park, NC*, ³*Genesis Midwest laboratories, Neillsville, WI*.

Genetically-modified (GM), herbicide-tolerant rice (LibertyLink[®], event LLRICE62), a near-isogenic (NI) conventional medium-grain rice, and a commercial long-grain, brown rice (CM) were assessed in diets for growing-finishing pigs. The GM and NI rice were grown in year 2001 under similar agronomic conditions. The GM rice was from fields treated (GM+) or not treated (GM-) with Liberty[®] herbicide. The GM+, GM-, NI, and CM rice were similar in composition (DM: 86.4, 85.5, 86.1, 86.6%; CP: 9.7, 10.3, 9.0, 9.2%; NDF: 3.5, 3.9, 3.6, 3.6; ADF: 1.4, 1.6, 1.9, 2.0%; Fat: 2.6, 2.7, 2.6, 3.4%; P: 0.33, 0.37, 0.32, 0.37%; lysine: 0.34, 0.36, 0.33, 0.33%; GE: 3.81, 3.82, 3.78, 3.94 Mcal/kg). Pigs (n = 96) were fed fortified rice-soybean meal diets containing the four rice grains from 25 to 106 kg BW. Diets contained 0.99% lysine initially, with lysine reduced to 0.80 and 0.65% when pigs reached 51 and 77 kg. The rice in diets was constant during each of the three phases (72.8, 80.0, 85.8%). There were six pen-replicates (three pens of barrows, three pens of gilts) and four pigs per pen. All pigs were killed at termination for carcass data. ADG, ADFI, and feed:gain were not different (P > 0.05) for pigs fed the GM vs conventional rice diets (0.86, 0.79, 0.81, 0.85 kg/d; 2.41, 2.49, 2.37, 2.45 kg/d; 2.80, 3.17, 2.95, 2.89 for GM+, GM-, NI, and CM rice, respectively). Carcass traits (adjusted for final BW) were not different (P > 0.10) among treatments (hot carcass yield: 73.5, 72.6, 72.6, 73.2%; 10th rib backfat: 23.0, 22.7, 21.3, 23.8 mm; longissimus area: 38.6, 38.0, 38.2, 38.1 cm²; estimated carcass fat-free lean: 50.5, 50.5, 51.2, 50.0%). Gilts grew slower (P < 0.01) and were leaner (P < 0.05) than barrows. Responses to type of rice were similar for the two genders with no evidence of a diet x gender interaction (P > 0.15) for any trait. The results indicate that the genetically-modified,

herbicide-tolerant rice was similar in composition and nutritional value to conventional rice for growing-finishing pigs.

Key Words: Pigs, Rice, Biotechnology

W68 Ultrastructural-chemical makeup of canola seed tissues explored with synchrotron reflection FTIR microspectroscopy: A preliminary study. P. Yu*¹, J. J. McKinnon¹, R. W. Newkirk², C. R. Christensen³, and D. A. Christensen¹, ¹*College of Agriculture, University of Saskatchewan, Saskatoon, Canada*, ²*Canadian International Grains Institute, Winnipeg, Canada*, ³*Canadian Light Source, Saskatoon, Canada*.

The objective of this study was to use synchrotron reflection FTIR microspectroscopy to explore the chemical makeup (functional group and bonding characteristics) of ultra-structural tissues of yellow (*Brassica Rapa* cv. Klondike) and brown-seeded (*Brassica Napus* cv. Bounty) canola. The investigated chemical bonding and functional groups included the NH&OH group with a broad band at 3298, CH groups (CH₃-asymmetric stretch at 2961; CH₂-asymmetric stretch at 2925; CH₃-symmetric stretch at 2871; and CH₂-symmetric stretch at 2853), amide I at 1650, carbonyl C=O ester stretch at 1740, and hemicellulose at 1240 and total carbohydrates (CHO) at ca. 1180-900 cm⁻¹ as well as their ratios. The results showed IR absorbed intensities (absorbance unit) of CH₃-asymmetric stretch of 0.060 and 0.056; CH₂-asymmetric stretch of 0.090 and 0.087; CH₃-symmetric stretch of 0.052 and 0.048; and CH₂-symmetric stretching of 0.045 and 0.043 for the yellow- and brown-seeded canola, respectively. The ratios of total CH₂:CH₃, CH₃-asymmetric:CH₃-symmetric, CH₂-asymmetric:CH₂-symmetric and total CH-asymmetric:CH-symmetric were 1.06 and 1.13, 1.28 and 1.26, 2.90 and 3.08, 1.82 and 1.78, for the yellow- and brown-seeded canola, respectively. The absorbed intensities (absorbance unit) of the peak area of the NH&OH, total CH, carbonyl C=O, amide I, hemicellulose, and total CHO were 101.623 and 87.123; 8.522 and 7.406; 0.387 and 0.414; 39.200 and 31.045; 1.445 and 1.329; 36.450 and 24.199 for the yellow and brown-seeded canola, respectively. The above results indicate the two varieties are potentially different in terms of ultrastructural-chemical makeup. The results also highlight the fact that synchrotron based reflection FTIR microspectroscopy can be used to determine the microstructural chemical bonding and functional group characteristics of canola tissue. Such information can be used for canola breeding programs for selecting superior varieties of canola for both oil and feed purposes and for prediction of canola quality and nutritive value for humans and animals.

Key Words: Synchrotron Infrared Microspectroscopy, Ultrastructural-Chemical Makeup, Canola

W69 Proximate and amino acid composition in different sources of rice bran for pigs. C. Kaufmann¹, W. Sauer¹, M. Cervantes*², M. Rademacher³, and J. He¹, ¹*Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta, Canada*, ²*Instituto de Ciencias Agrícolas, Universidad Autónoma de Baja California, Mexicali, BC, Mexico*, ³*Degussa-Huls AG, Hanau-Wolfgang*.

A study was conducted to determine the proximate and amino acid (AA) composition of five samples of rice bran (RB), as well as the relationship between their crude protein and AA content. Five different sources of RB were evaluated: RB 1, Canadian source; RB 2, Riceland Foods Inc., Stuttgart, AR; RB 3, Agribands International, Italy; RB 4, North Luzon Region, Philippines; and RB 5, Agribands/Tradico, Greenville Feed Facility, Greenville, MS. The contents of crude fat (CF), NDF, ash, and CP in RB 1, 2, 3, 4, and 5 were (%): 23.4, 4.1, 24.4, 5.4, and 20.7; 26.4, 26.0, 34.3, 2.1, and 25.5; 21.0, 12.7, 11.0, 4.8, and 16.3; 15.6, 21.0, 15.8, 13.6, and 18.1, respectively. There were considerable variations in the contents of CF, NDF, ash, and CP. The indispensable AA composition (%) in RB 1, 2, 3, 4, and 5 were: Arg, 1.32, 1.73, 1.29, 0.99, and 1.45; His, 0.44, 0.61, 0.44, 0.34, and 0.50; Ile, 0.51, 0.68, 0.56, 0.44, and 0.59; Leu, 1.05, 1.38, 1.14, 0.94, and 1.22; Lys, 0.69, 0.88, 0.75, 0.45, and 0.76; Met, 0.30, 0.40, 0.33, 0.31, and 0.34; Phe, 0.65, 0.86, 0.71, 0.60, and 0.76; Thr, 0.56, 0.75, 0.62, 0.46, and 0.65; Val, 0.80, 1.04, 0.87, 0.64, and 0.89; Trp, 0.20, 0.28, 0.20, 0.17, and 0.22, respectively. Arg and Leu were the most abundant indispensable amino acids in RB, whereas His, Met, and Trp were the least abundant. The relationships between the content of CP (Y) and each AA (X) were: Arg, Y = 0.0825 - 0.1958X (R² = 0.96); His, Y = 0.0308 - 0.1088X (R² = 0.98); Ile, Y = 0.0271 +

0.0347X ($R^2 = 0.96$); Leu, $Y = 0.0502 + 0.1611X$ ($R^2 = 0.97$); Lys, $Y = 0.0449 + 0.134X$ ($R^2 = 0.79$); Met, $Y = 0.0114 + 0.1025X$ ($R^2 = 0.85$); Phe, $Y = 0.0298 + 0.1259X$ ($R^2 = 0.97$); Thr, $Y = 0.0324 + 0.0104X$ ($R^2 = 0.93$); Val, $Y = 0.0439 + 0.0085X$ ($R^2 = 0.91$); Trp, $Y = 0.0116 + 0.0093X$ ($R^2 = 0.96$). There was a linear increase in the content of all AA as the content of CP increased ($P < 0.05$). This study shows that there is considerable variation in the proximate and AA composition in the RB. This also indicates that the AA content in RB can be predicted on the basis of its CP content.

Key Words: Pigs, Rice Bran, Amino Acid Digestibility

W70 Maturity zone effects on composition of soybean meals sampled from 55 U.S. processing plants. L. K. Karr-Lilienthal*, C. M. Grieshop, J. K. Spears, and G. C. Fahey, Jr., *University of Illinois, Urbana.*

Variation in soybean meal (SBM) composition can affect nutrient digestibility of SBM by swine. To quantify variation in U.S. SBM, samples were collected from 55 U.S. processing plants three times at two week intervals (sampling times 1, 2, or 3). These samples were analyzed for crude and acid hydrolyzed fat as well as oligosaccharide and amino acid concentrations. Comparisons were made among SBMs according to maturity zone (1-7) where the SBMs were prepared and sampling times (1-3). Acid hydrolyzed fat concentrations were 1.5 to 3.3 times higher than crude fat concentrations, were greatest ($P < 0.05$) at the second sampling time, and increased for processing plants located in the southern U.S. (3.9 to 4.3% for zones 1 and 7, respectively). Oligosaccharide concentrations varied depending on sampling time and maturity zone. Raffinose concentrations decreased ($P < 0.05$) over time from 12.66 to 11.92 mg/g and verbasco concentrations were lowest for collection 3 (1.70 vs. 1.90 mg/g for collections 1 and 2), while stachyose concentrations increased over time from 51.78 to 53.52 mg/g. Concentrations of stachyose were highest for SBM prepared in zones 3 (55.6 mg/g) and 4 (55.2 mg/g), while verbasco concentrations were highest for samples collected in the southern U.S. Total essential amino acid (TEAA) and total amino acid (TAA) concentrations increased over time from 22.0 to 23.5% and 51.1 to 53.1%, respectively. For the processing plants located in the southern U.S., TEAA concentrations increased (22.3% for zone 1 vs. 23.7% for zones 5 and 6). The lowest TAA concentrations were noted for SBMs prepared in zones 1 (50.8%) and 2 (51.0%). Soybean meals produced in southern maturity zones contained higher concentrations of acid hydrolyzed fat and TEAA. There was variation in oligosaccharide and amino acid concentrations over time, probably due to variation in composition of soybeans arriving at the processing plant.

Key Words: Amino Acids, Oligosaccharides, Soybean Meal

W71 Sensory tests reveal that the efficacy on masking capacity of a strawberry flavor changes with different protein sources and their level in feed. I. Pérez-Portabella, C. Puyuelo, C. Ibáñez, J. Solà, and E. Roura*, *Lucta SA, Barcelona, Spain.*

In piglet diets several types of protein sources are included and often subsequently substituted. Flavors are used to mask these and other dietary changes, thus avoiding olfactory cues that could depress feed intake. Sensory-based procedures were developed to assess the effect of some protein sources and their in-feed level on the efficacy of a strawberry flavor. Firstly, the detection threshold on a salt base for fishmeal, animal plasma and soybean meal was measured by a 15-member expert panel (7 women and 8 men) according to the standard practice (ASTM-E679). In a second step, each one of the three protein sources were mixed at 0, 3, 6 and 12% with corn meal, and 400 ppm of a strawberry flavor was added to all samples. Flavor intensity and masking capacity for each sample was evaluated by 8 panelists and results analyzed by the Tukey B test for differences in type of protein source and level of inclusion. The results of the first study show that fishmeal had the lowest detection threshold at only 5 ppm, animal plasma was detected at 162 ppm and soybean meal at 288 ppm. Women were capable of detecting lower levels than men in all three feedstuffs. Regardless of the protein, the higher the level the lower the flavor intensity. Particularly the level of fishmeal inclusion linearly affected both intensity of the strawberry flavor ($y = -2.3x + 76.4$, $R^2 = 0.77$) and its masking capacity ($y = -4.1x + 76.2$, $R^2 = 0.89$), while the effect of plasma levels ($R^2 \leq 0.6$) and soybean meal ($R^2 \leq 0.3$) did not appear to follow linearity.

Differences due to the protein source on both intensity and masking capacity were significant ($P < 0.05$) at 6% and 12% inclusion, with fishmeal affecting more than plasma and plasma more than soybean meal (but not at 3%). It is concluded that the lower the detection threshold of fishmeal, animal plasma and soybean meal the higher the impact on the flavor intensity and its masking capacity. Flavor responses to the protein inclusion rate was linear only for fishmeal.

Key Words: Protein Sources, Odor Detection Threshold, Strawberry Flavor

W72 An improved method for the rapid determination of phytase activity in animal feeds. T.W. Kim* and X.G. Lei, *Cornell University, Ithaca, NY.*

The current direct colorimetric assay for phytase activity in feeds is interfered by high phosphorus background and other factors. The objective of this experiment was to develop a rapid and reliable spin column method to accurately determine phytase activity in feed ingredients or complete diets. After the feed sample was extracted in 0.2 M citrate buffer, pH 5.5, for 30 min at room temperature, the oily layer of the supernatant was removed by passing an acrodisc syringe filter (0.45 μ m HT Tuffryn membrane, Gelman Laboratory, Ann Arbor, MI). The filtrate was then loaded onto a spin column (MW cutoff 30,000, Millipore, Bedford, MA) to remove free inorganic phosphate prior to the phytase activity assay. Compared with the direct assay, this new procedure improved both accuracy and reproducibility. When diets contained phytase at 0-1,000 units/kg, the coefficients of variation for multiple assays of the same samples ($n = 6$; dietary enzyme levels = 5) by the new method ranged from 1.3 to 4.1%, but 10 to 39% by the direct method. There was a linear regression between the added phytase activity and the actual activity measured by the new method ($R^2 = 0.997$; $P < 0.001$). By concentrating the sample during spin column filtration, the new method could be used to accurately detect low levels of phytase in diets (10 units/kg). In conclusion, this spin column method is considered an improved assay for phytase activity in animal feed, and may be used for quality control of phytase supplementation.

Key Words: Phytase, Phosphorus, Feed enzyme

W73 The effect of dietary calcium on indicators of bone turnover in mares. B. D. Cassill*, S. Hayes, J. Ringler, K. Janicki, and L. Lawrence, *University of Kentucky, Lexington.*

Preliminary studies in our laboratory have found that serum ICTP (carboxy-terminal pyridinoline cross-linked telopeptide region of type I collagen), an indicator of bone turnover, is increased shortly after foaling suggesting mares mobilize bone mineral during lactation. This study was conducted to determine whether dietary calcium and phosphorus concentration would affect indicators of bone turnover in mares during late lactation and after weaning. The study used 12 mares (average age 10 ± 4.8 y) split into 2 groups. Groups were balanced for age and parity. The control group was fed to meet all NRC (1989) requirements. Group H was fed to meet all NRC (1989) requirements, plus enough dicalcium phosphate to increase calcium intake to 150% of the recommended level. The study was initiated at 2.5 mo of lactation and lasted for 16 wk which included 56 d of lactation and 56 d after weaning. Body weights were obtained every 14 d and blood samples were collected every 28 d for the duration of the study. Milk samples were collected every 28 d for the first 56 d. Calcium concentrations of milk were determined using atomic absorption spectrophotometry. Serum was analyzed for ICTP using radioimmunoassay. ICTP concentration in serum decreased over time ($P = 0.057$) but was not affected by diet ($P = 0.363$). Calcium concentration in milk decreased over time ($P = 0.005$) but was not affected by diet ($P = 0.236$). Average daily gain of the foals was not different between groups ($P = 0.675$). Increasing dietary calcium and phosphorus intake by mares did not affect milk calcium or serum ICTP concentrations during late lactation or in the first 2 mo after weaning.

Key Words: Horse, Lactation, Calcium

W74 Partitioning of metabolizable energy by rainbow trout and Atlantic salmon using a multivariate approach: species and diet effects. P.A. Azevedo*, S. Leeson, C.Y. Cho, S. Birkett, and D.P. Bureau, *University of Guelph, Ontario, Canada.*

A study was conducted to investigate how the allocation of energy to growth and maintenance differs between rainbow trout and Atlantic salmon and how the diet affects energy allocation. Rainbow trout and Atlantic salmon were handfed to satiation four isoenergetic diets (DE = 20 MJ/kg) with different digestible protein/digestible energy ratios (DP/DE), i.e., 24, 22, 20, and 18 g/MJ, achieved through reduction of DP level (53 to 39%) and increase of lipid level (19 to 26%). Intake of metabolizable energy (ME), protein (PD), and lipid (LD) gain were determined. Data were analyzed by multivariate analysis of PD and LD on ME. Maintenance energy requirements (ME_m) and efficiency of ME utilization for PD (k_p) and LD (k_l) were estimated. The fraction of ME intake above maintenance for PD (X) was defined as linear function of body weight with slope (d) and intercept (c) estimated simultaneously with the above parameters. The ME_m did not differ (P > 0.05) be-

tween rainbow trout and Atlantic salmon (20 kJ/day/kg^{0.8}). On the other hand, K_p, c, and d were significantly different (P < 0.05) between the two species, independently of the diet. The ME intake above ME_m channeled towards PD (c) was higher in salmon than trout (57 vs. 55%; P < 0.05). The change in partitioning of ME toward PD due to the change in body weight was negative for trout (d = -0.18) while it was positive for salmon (d = 0.16). The values of d agreed well with the increase of LD/PD with body weight for trout and the decrease of LD/PD with body weight for salmon which may have been related to the maturation status of this fish and the associated loss of lipid observed with maturing salmon. The K_p was significantly higher for salmon compared to trout (0.52 ± 0.06 vs. 0.43 ± 0.06; P < 0.05) and independent of the diet while K_l was 0.81 ± 0.13 irrespective of species or diet. Lower cost of protein deposition for salmon compared to trout suggests differences in protein metabolism between these two species. Studies on protein turnover rates and metabolic utilization of nutrients for PD are required to gain insight on k_p differences between salmon and trout.

Key Words: Rainbow Trout, Atlantic Salmon, Energy Allocation

Nonruminant Nutrition: Sow & Gilt Nutrition

W75 Ideal protein to improve lactation performance of multiparous sows. F. Ji*¹, Y. G. Kim², and S. W. Kim¹, ¹Texas Tech University, Lubbock, ²CJ Corporation, Seoul, Korea.

The objective of this study was to validate the ideal dietary amino acid pattern in lactation diets to improve the performance of multiparous sows during lactation. Thirty two (20 second and 12 third parity Camborough-22) sows and their litters were used for this study. On d 109 of gestation, sows with a similar body weight were grouped and allotted to one of four dietary treatments representing: low protein (LC), low protein with ideal protein (LI), high protein (HC), and high protein with ideal protein (HI). Low protein diets contained 17.5% CP and high protein diets contained 19.5% CP. Ideal amino acid patterns among lysine, threonine, and valine were 100:63.0:78.1 (lys:thr:val) for the LI diet and 100:62.3:77.5 for the HI diet when it was calculated based on ileal digestible amounts. To match amino acid pattern to ideal ratios, crystalline amino acids were supplemented. Crude protein contents in the diets with ideal protein pattern were matched to the control diets by adjusting SBM content as crystalline amino acids were added. Weight and backfat thickness of sows as well as the weight of each piglet were measured at farrowing and weekly until weaning at d 21 of lactation. All sows had free access to feed and water during lactation. The body weight of sows after farrowing (224.5±4.5 kg) and litter size at farrowing (10.2±0.2 pigs) were the same (P=0.361 and 0.779, respectively) among the treatments. Voluntary feed intake of sows (5.63±0.22 kg/d) did not differ (P=0.911) among the treatments. Sows fed the low protein diets had greater (P<0.05) weight loss than sows fed the high protein diets. Sows fed the diets with ideal protein tended to have smaller (P=0.051) weight loss than sows fed the control diets. For the second parity sows, there were no differences in backfat loss, litter size at weaning and litter weight gain among the treatment. However, weight loss of the HI sows was smaller (P<0.05) than the LC sows. For the third parity sows, there were no differences in lactation performance among the treatments.

Key Words: Lactation, Multiparous sows, Ideal protein

W76 Utilization of seaweed (*Macrocystis pyrifera*) meal in wheat-based diets for lactating sows. J. Baeza¹, M. Cervantes*², J. L. Figueroa¹, E. Chi¹, M. Cuca¹, and N. Torrentera², ¹Ganadería, Colegio de Postgraduados, Montesillos, Mexico, ²ICA, Universidad Autónoma de Baja California, Mexicali, BC, Mexico.

There is interest in alternative ingredients to enhance productive performance of animals without damage to the environment. Therefore, an experiment was conducted to evaluate the addition of seaweed (*Macrocystis pyrifera*) to wheat-based diets for lactating sows on milk production and composition, daily litter gain, and wean to first oestrous interval of sows. Thirty two multiparous sows (Landrace x Duroc x Yorkshire) were fed four diets with eight replicates. Treatments were: T1) wheat-soybean meal, basal diet; T2) T1+1.5% seaweed; T3) T1+3.0% seaweed; and T4) T1+4.5% seaweed. Litters were standardized to eight piglets

and milk production was estimated at 6, 13, 20, and 27 d by the double-weight method; milk protein concentration was determined at 13 and 27 d. Piglet weights at weaning and daily weight gain, sows milk production, and number of weaned piglets for treatments 1 to 4 were: 7.30, 7.22, 7.21, 7.01 kg; 201, 196, 196, 186 g/d; 5.98, 5.35, 5.75, 6.13 kg/d; 7.86, 7.71, 7.38, 7.87, respectively. Seaweed addition did not affect the analyzed variables. A linear effect was observed (P < 0.05) between productive variables (litter daily gain, milk production, sows feed intake) and days on lactation. The peak of milk production was observed between the third and fourth weeks of lactation. The litter weight gain and feed intake were highest in the fourth week. These results suggest that seaweed addition to lactating sow diets does not affect productive and reproductive performance of lactating sows and their litters.

Key Words: Sows, Lactation, Seaweed

W77 The importance of dietary selenium on antioxidant status and hormonal profile in post-pubertal gilts. M.-É. Fortier*¹, H. Quesnel², A. Giguère³, J.-F. Bilodeau¹, J.-P. Laforest¹, and J. J. Matte³, ¹Université Laval, Quebec, Canada, ²Institut de la Recherche Agronomique, St. Gilles, France, ³Agriculture and Agri-Food Canada, Lennoxville, Quebec, Canada.

This project aimed to determine the effect of selenium (Se) as inorganic Na-selenite (MSe) or organic Se-yeast (OSe) on antioxidant status and hormonal profile, after puberty and in early gestation of gilts. Forty-nine gilts were allocated to one of the 3 feeding treatments at first estrus: control (C: basal diet (Se=0.2 ppm) without added Se) (n=16), MSe (C+0.3 ppm Se) (n=16) and OSe (C+0.3 ppm Se) (n=17). Treatments started at the day after the first pubertal estrus and lasted up to 30 d post-AI (AI at the fourth estrus). Blood was collected from all gilts on the day after each estrus and on d 30 post-AI. Blood was also collected daily from d -4 until d +4 of the third onset of estrus (d 0) in 8 C, 9 MSe and 8 OSe canulated gilts. Blood Se was lower (P<0.01) in C than in Se groups and higher in OSe than in MSe (P<0.01) (C:249±6, MSe:273±6 and OSe:316±8 µg/L on d 30 post-AI). Blood Se-GSH-Px tended to be lower (P<0.06) in C than in Se groups starting at third estrus and was higher (P<0.01) in MSe than in OSe starting at AI (C:2078±74, MSe:2594±84 and OSe:2392±105 mU/mg hemoglobin on d 30 post-AI). Plasma T3, a Se-related hormone, was not altered by treatments (P>0.12) prior to AI but, during gestation, T3 decreased markedly (P<0.03), values for MSe being lower (P<0.02) than for OSe on d 30 of gestation (C:90±2, MSe:79±5 and OSe:94±3 ng/100mL). In canulated gilts, plasma FSH was lower (P<0.04) for MSe than for C on d +2 and d +3. On d +4, FSH (C:0.88±0.12, MSe:0.94±0.19 and OSe:1.27±0.20 ng/mL) and T3 (C:88±12, MSe:75±7 and OSe:97±16 ng/100mL) values became higher (FSH, P<0.05) or tended to be higher (T3, P<0.07) for OSe than MSe. There was no treatment effect (P>0.10) on the profile of LH or E2 during the third estrus. In summary, the Se status response to dietary Se was not reflected on Se-GSH-Px which responded to Se supplements but, in a different way, to the type of Se supplements. Taking into account the role of T3 in FSH synthesis, the FSH and T3 effects after estrus merit

further investigation as well as the T3 response to OSe vs MSe during gestation.

Key Words: Selenium, Post-Puberty, Gilts

W78 The effect of mannan oligosaccharides on reproductive performance in sows. P. Medel*¹, C. Piñero², A. Kocher³, F. Baucells¹, and M. I. Gracia¹, ¹Imasde Agropecuaria, S.L., Spain, ²PigChamp Pro Europa, Spain, ³Alltech Inc, Ireland.

This study was conducted to determine the effect of including mannan oligosaccharides (MOS, Bio-Mos[®]) in diets fed to gestating and lactating sows on their productivity. A total of 80 gestating sows (Landrace × Large White), selected two weeks before the expected farrowing, were randomly allotted to one of two treatment groups taking into account their parity number. The two treatments were as follows: 1) basal diet (control), 2) basal diet with a source of MOS at 2 g/kg in gestation and 1 g/kg in lactating diets. Diets were formulated to contain 18.5% CP and 2.4 Mcal NE/kg. During lactation, all sows were allowed ad libitum access to their treatment diets. Feeding the experimental diets began two weeks before farrowing and continued until weaning of piglets. Sow BW was measured at 107 d of gestation and at weaning. Backfat depth was measured using ultra sound 24 h and 14 d after farrowing, and at weaning. ADFI was recorded daily. Pigs were weighed 24 h after birth and at weaning. Number of piglets born alive, pre-wean mortality and ADG were recorded. Sow weight change, backfat depth change, and ADFI did not differ between treatments (P>0.05). Also, the number of pigs born (11.2 vs 11.9) and pre-wean mortality (1.00 vs 0.88) did not differ between control and MOS supplemented sows (P>0.05). However, piglet birth (1.54 vs 1.70 kg) and weaning weights (6.52 vs 7.12 kg) were 0.16 and 0.60 kg heavier, respectively (P<0.05) for MOS supplemented sows when compared to control sows. These data suggest that MOS supplementation of sow diets during the end of gestation and lactation increases both piglet birth and weaning weights.

Key Words: Mannan Oligosaccharides, Birth and Weaning Weight, Lactating Sows

W80 The Effect of Distillers Dried Grains with Solubles as the Protein Source in a Creep Feed. P. Lancaster, J. Williams*, J. Corners, L. Thompson, D. McNamara, and M. Ellersieck, University of Missouri, Columbia.

A study was conducted to evaluate the effect of Corn Distillers dried grains with solubles (D) vs. soybean meal (S) as a protein source in a creep feed over 2 years. In yr 1 and 2, thirty-six steer calves (avg. 159.9 kg + 26.9 in yr 1; 184 kg + 12.7 in yr 2) were used to compare the effects of D and S on the performance of calves to traditionally weaned (C) calves prior to (68 d) and after weaning (112 d). Steers were randomly allotted by age to 6 endophyte-free tall fescue pastures in yr 1 and blocked by age within sire and randomly assigned to 3 of the same pastures in yr 2. The dietary supplements consisted of a cracked corn / soyhull mix with the protein source and were formulated to contain 14.2 % CP and 1.39 Mcal/kg of NEg. In both years, steers were placed in open drylots upon weaning and adjusted to a receiving diet of cracked corn, soyhulls, and fescue hay with D and S treatments continued, while the C treatment received S as the protein source. After 112 d, steers were placed on a common urea based finishing diet. In yr 1 and 2, creep-fed calves had greater (P < .01) ADG than non-creep-fed calves during pasture phase (1.03 vs. 0.72 and 1.03 vs. .88 kg/d for year 1 and 2, respectively). In yr 1, the feed / extra gain was similar among treatments, while cost / kg of extra gain for D was lower (P < .05) than S (0.88vs.1.89, respectively). Weaning weight was greater (P < .05) for creep-fed than non-creep-fed calves (231.0 vs. 206.6 kg, respectively). There was a trend for creep-fed steers to have a greater (P = .09) ADG than non-creep-fed steers during the feedlot phase (1.66 vs. 1.57 kg/d, respectively). Creep-fed steers had greater (P < .05) final and hot carcass weights than non-creep-fed steers (537.2 vs. 496.7 and 329.2 vs. 300.0 kg for final and carcass weights, respectively). In yr 2,

W79 The influence of feed intake during mid-gestation on performance of pregnant sows and progeny growth: a preliminary study. A. Cerisuelo¹, R. Sala¹, J. Coma², D. Carrión*³, J. Gasa¹, and M. Baucells¹, ¹Universitat Autònoma de Barcelona, Spain, ²Agrocesa, S.A., Spain, ³PIC España, S.A., Spain.

The effect of increased feed intake during mid-gestation (secondary fiber hyperplasia period) on sow performance and progeny growth was studied. A total of 101 pregnant sows of different parity were assigned to two dietary treatments: Control, C (n=48) were fed at a level routinely used on commercial farms (3.16 kg d⁻¹) and Experimental, E (n=53) received 1.75 times C from d 50-85 of gestation. Body weight was recorded at d 45 of gestation, at 48 ± 24h post-partum and at weaning. Backfat thickness at P2 was determined on d 45, 84 and 110 of gestation and on d 18 of lactation. Increases in P2 from d 45-80 of gestation were higher (P<0.05) in E sows. Moreover body weight losses in lactation period were lower in E sows (P<0.10), while decreases in P2 were similar between treatments. Average piglet weight when weaned at about d 23 was not affected by treatment (P>0.05). Castrated males (n=460) were used for a post-weaning study. Animals were divided by treatment (C vs E) into five weight groups each and daily gains were recorded for six weeks postweaning. Growth rate of E group was greater than that of the C group being statistical significant from day 30 post-weaning (Table 1). The greatest differences in growth rate were observed in the lightest groups of pigs. Results suggest that increasing sow feed intake during mid-gestation may improve postnatal growth rate of piglets. More studies are needed in order to check the long term influence in sow performance.

Body weight throughout the weaning period.

Days post-weaning	Body weight, kg		Treatment dif., g/pig	P-value
	Control	Exp.		
0	6.5	6.5	0	NS
14	7.8	8.0	-189	0.12
22	9.9	10.2	-253	0.11
30	13.5	14.1	-580	0.015
42	19.9	20.6	-722	0.014

Key Words: Sow Performance, Growth, Maternal Nutrition

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DMI, feed / extra gain, and cost / kg of extra gain were similar but total feed costs were lower (P < .01) for D than S during the pasture phase (13.88vs.18.31, respectively). Final performance and carcass data for yr 2 will be presented later. In conclusion, protein source had no effect on ADG, however DDGS reduced feed costs.

Key Words: DDGS, Creep Feeding, Rumen Undegradable Protein

W81 Effects of sire marbling EPD and creep feeding on feedlot performance and carcass characteristics of Hereford calves. J. E. Rossi*¹, T. D. Pringle², and J. K. Bertrand², ¹University of Georgia, Tifton, ²University of Georgia, Athens.

Five-month old nursing Hereford calves (forty-six heifers and forty-one steers; initial BW = 166.6 ± 4.4 kg) were used to determine the effects of sire marbling EPD and creep feeding on feedlot performance and carcass characteristics. Treatments were arranged in a 2 × 2 factorial with factors being sire marbling EPD (high +2.8 or low -2.3) and creep or no creep feeding. Cows and calves were allotted to 8 fescue/bermudagrass mixed pastures with 2 pastures per treatment. Heifers and steers were evenly allotted among pastures within each sire marbling group. Calves were creep fed a 50:50 mixture of ground corn and corn gluten feed for 90 days. All calves were then commingled into a single group and pre-conditioned for 45 days prior to finishing on a 90% concentrate diet. Heifers were fed 169 days and steers were fed 183 days. Calves that were creep fed consumed 2.45 kg (DM basis) of creep feed per day. Daily gains during the creep feeding period were greater (P < 0.01) for calves that were creep fed (1.26 kg/d) versus not creep fed (0.95 kg/d). Daily gains during the creep feeding period were not affected (P = 0.37) by sire marbling EPD. Feedlot ADG was not affected (P > 0.38) by creep feeding or sire marbling EPD. Carcass marbling scores were 10% greater (p =

0.06) for calves creep fed compared with calves not creep fed. Marbling score was not affected by sire marbling EPD ($P = 0.70$). Fat thickness was 12% greater ($P < 0.05$) for creep fed versus non creep fed calves and was 12% greater ($P < 0.05$) for calves sired by a low versus high marbling EPD bull. Ribeye area and dressing percentage was not affected ($P > 0.10$) by creep feeding or sire marbling EPD. Yield grade was greater ($P < 0.01$) for creep fed (3.34) versus non creep fed calves (3.04), and greater ($P < 0.01$) for calves sired by low (3.36) versus high (3.01) marbling EPD bulls. Carcass marbling scores were increased by creep feeding but were not affected by sire marbling EPD.

Key Words: Calves, Creep Feeding, Carcass Characteristics

W82 Effects of feeding byproducts on animal performance and carcass characteristics of finishing beef cattle grazing tropical grass during dry season. A. A. Souza^{*3}, C. Boin¹, M. Q. Manella¹, and A. J. Lourenço², ¹ESALQ/USP, Brazil, ²Instituto Zootecnia, Brazil, ³UNESP, Brazil.

This study has evaluated the effects of feeding byproducts on animal performance and carcass characteristics of Nelore cattle grazing tropical pastures during the dry season. The trial was conducted at Instituto de Zootecnia in Nova Odessa, São Paulo state in Brazil. The performance of 128 Nelore steers was evaluated in a random block design, with four treatments and four replications. The treatments were: Control = *Brachiaria brizantha* + mineral supplement; Leucena = *Brachiaria brizantha* + protein bank (*Leucaena leucocephala*) + 1.8 kg citrus pulp + 0.8 kg Wet corn gluten feed + mineral supplement (animal/day); Supl1 = *Brachiaria brizantha* pasture + 1.8 kg citrus pulp + 0.8 kg Wet corn gluten feed + 0.45 kg soybean meal + mineral supplement (animal/day); Supl2 = *Brachiaria brizantha* pasture + 1.8 kg citrus pulp + 0.8 Kg Wet corn gluten feed + 0.9 kg soybean meal + mineral supplement (animal/day). The initial and final live weight was 416-434; 399-475; 395-490 and 395-488 kg for treatments control, leucena, supl1 and supl2, respectively. After 5 months of trial, animals that had at least 3 mm back fat measured by ultrasound were slaughtered at a commercial plant. The average daily gains were 0.114; 0.528; 0.638 and 0.613 kg/animal/day for control, leucena, Supl1 and 2, respectively (table 1). There were greater carcass yields for the supplemented animals of the treatments leucena, Supl1 and 2. The results of backfat have been like the yield carcass results (table 1). The use of byproducts as grazing supplements may finish grazing animals, with greater backfat thickness. Table 1. Average daily gains and backfat after chilled for different treatments.

Treatments	Kg/animal/day	Backfat	CarcassYield (%)
Control	0.114 ^a + 0.051	3.30 ^a + 0.20	53.9 ^a
Leucena	0.528 ^b + 0.042	4.24 ^{ab} + 0.31	55.6 ^b
Supl1	0.638 ^c + 0.035	4.75 ^b + 0.33	55.6 ^b
Supl2	0.613 ^c + 0.031	4.87 ^b + 0.40	56.4 ^b

*Means with unlike superscripts are different ($P < 0,05$)

Key Words: Beef Cattle, Byproducts, Backfat Thickness

W83 Effect of supplements of self feed on efficiency of microbial protein synthesis and excretion of N contents - urea in steers grazing *Brachiaria decumbens*, in the rainy season. J. Tilemahos Zervoudakis^{*1}, M. Fonseca Paulino², L. Cabral¹, E. Detmann³, S. de Campos Valadares Filho², E. Henrique Bevtori Kling de Moraes², and A. Lima de Souza¹, ¹Universidade Federal de Mato Grosso, Fernando Correa da Costa, Cuiaba-MT-Brazil, ²Universidade Federal de Viçosa, Viçosa, MG, Brazil, ³Universidade Estadual Norte Fluminense, Campos dos Goytacazes-RJ, Brazil.

The objective this work was evaluate the effect of supplements of self feed on the efficiency of microbial protein synthesis and excretion of N contents - urea in the urine of steers grazing *Brachiaria decumbens*, in the rainy season, in the west-central region of Brazil. Four crossbred steers, fistulated in the rumen, abomasum and esophagus, with average initial weight of 426 kg, were used for evaluating nutritional parameters, by 4x4 latin square. Mineral salt (SALT) and supplements based on:

urea, mineral mix, grounded corn grain and soybean meal (SBM); urea, mineral mix, soybean meal and corn gluten meal (SBMCG); and urea, mineral mix, wheat bran and soybean meal (WBSBM), with average protein content of 53.60% CP, were fed daily, at level of 1.0 kg/animal, at 10:00 hours. The microbial protein production was calculated by purine determination on rumen and abomasum samples, used purine basis as marker adoted a N-purine:N-total of 0.117. The urea excretion on urine was determined by urine spot colleted 4 hours after supplementation. The animals supplemented excreted higher N content - urea in the urine (95.28 g/day)($P < 0.05$) than the control animals (46.90 g/day). No effect of treatments on the efficiency on microbial protein synthesis in the g CP microbial/100 g TDN, was observed, with average values of 11.75 g CP microbial/100g TDN.

Key Words: Microbial Nitrogen, Supplementation, Steers

W84 Effects of CLA on tissue response to homeostatic signals and plasma lipid metabolism variables in growing beef steers. O. B. Mendivil^{*}, C. E. Moore, H. C. Haflliger III, S. R. Sanders, G. C. Duff, and L. H. Baumgard, *The University of Arizona, Tucson.*

The ability of CLA to modify beef body composition and the mechanism by which it alters lipid metabolism are poorly understood. Objectives of this study were to evaluate basal energetic and temporal metabolite patterns in response to epinephrine, insulin, and glucose challenges in cattle fed rumen protected (RP) CLA. Twenty British x Continental beef steers (280 ± 29 kg BW) were fed isoenergetic steam-flaked corn based diets containing equal amounts of FA (5.74 vs 6.25% EnerGII[®], a RP palm oil and RP CLA, respectively) for 45 d. The CLA supplement contained 71.4% FA of which 40.0% were CLA isomers (5.4% *t*-8, *c*-10; 6.3% *c*-9, *t*-11; 7.9% *t*-10, *c*-12; and 8.2% *c*-11, *t*-13 CLA). Controls were pair-fed with CLA steers in order to minimize caloric intake variability. All steers were fitted with indwelling jugular catheters on d 14, 28, and 42. Epinephrine (1.4 µg/kg BW), insulin (3.0 µg/kg BW), and glucose (0.3 g/kg BW) challenges were conducted and blood samples collected on d 15, 30 & 43; 16, 31 & 44; and 17, 32 & 45, respectively. Subcutaneous adipose tissue was collected from the tailhead region in 10 randomly selected steers (n=5/trt) on d 45. Production variables (ADG, G:F, BW, DMI and DMI as %BW) did not differ ($P > 0.15$) between treatment groups. Dietary CLA did not alter basal circulating plasma NEFA or glucose concentrations. In addition, there were no CLA effects on metabolic responses to the aforementioned homeostatic signals. On d 45, adipose tissue of CLA-fed steers had increased ($P < 0.03$) concentrations of *c*-9, *t*-11 CLA (0.78 vs 0.52%), *t*-10, *c*-12 CLA (0.21 vs 0.08%), total CLA (2.85 vs 0.97%), and total *t*-18:1 FA (8.92 vs 5.70%). There were no effects on the Δ^9 -desaturase index (43.3) or the total saturated and unsaturated levels (45.7 and 54.3%, respectively). These data indicate that short term CLA supplementation did not alter basal or stimulated NEFA or glucose parameters, but has the ability to dramatically increase CLA content in bovine adipose tissue.

Key Words: CLA, Beef, Lipid Metabolism

W85 Dietary effect on n-3 fatty acids, CLA and C18:1trans isomers in beef and lamb meat. K. Nuernberg^{*1}, D. Dannenberger¹, G. Nuernberg^{*1}, N. Scollan², W. Zupp³, and K. Ender¹, ¹Research Institute of the Biology of Farm Animals, Dummerstorf, Wilhelm-Stahl-Allee, Germany, ²Institute of Grassland and Environmental Research, Aberystwyth, UK, ³Research Institute of Agriculture and Fishery Mecklenburg-Pomerania, State Institute for Animal Production, Dummerstorf, Wilhelm-Stahl-Allee, Germany.

The objective of the experiments with cattle and lambs was to produce high quality beef and lamb meat under different feeding conditions and to accumulate the concentration of n-3 fatty acids and CLA in muscle. In total 33 German Holstein bulls (initial liveweight= 205 kg) were fed on either an indoor concentrate system or a period of summer pasture feeding on grass following by an indoor finishing. Bulls were slaughtered at 620 kg. Pasture feeding caused significant increased relative contents of linolenic acid (C18:3n-3) and long-chain n-3 fatty acids in muscle. Relative proportion of CLA_{cis-9,trans-11} was significantly ($P \# 88040.05$) higher in grass fed bulls. The absolute content was not affected by the diet. The main CLA_{cis-9,trans-11} of muscle lipids measured by HPLC decreased from 73.5 % in concentrate fed bulls to 65.0 % in grazing bulls. The second most abundant CLA isomer in pasture fed bulls was CLA_{trans-11,cis-13} and the isomer CLA_{trans-7,cis-9} in concentrated fed

bulls. There was a feeding influence on the relative proportion of all C18:1trans isomers. The absolute amount of C18:1trans-11 was only in tendency increased in grazing bulls (66.2 mg/100 g fresh muscle vs 101.7 mg/100 g). In total 13 male lambs (Black Head x Gotland) were divided into two feeding groups at 24 kg live weight. Lambs (n=6) were kept either on pasture (salt grass) or in stable on concentrate (n=7). Lambs fed grass accumulated a higher C18:3n-3 content and the sum of n-3 fatty acids in muscle lipids. The relative content of CLA_{cis-9,trans-11} (1.9 % vs 1.1 % in muscle) was significantly (P#88040.05) higher by grazing on pasture compared to concentrate feeding. The analyses of CLA isomers (Ag+-HPLC analysis) showed no differences between feeding systems for CLA_{cis-9,trans-11}. The percentage of the CLA_{trans-10,trans-12} isomer was five times higher in concentrate fed lambs vs pasture feeding. The main C18:1trans isomers of intramuscular fat in lambs were C18:1trans-11, C18:1trans-14, C18:1trans-15 and C18:1trans-16. Grass feeding increased significantly the percentage of C18:1trans-11.

Key Words: n-3 Fatty Acid, CLA Isomers, Muscle

W86 Effect of CRINA RUMINANTS, a mixture of essential oil components, on continuous culture fermentation and milk production of lactating cows. G. Varga¹, E. Block^{*2}, P. Williams³, T. W. Cassidy¹, and R. Losa⁴, ¹The Pennsylvania State University, University Park, ²Church & Dwight Co., Inc, Princeton, NJ, ³Akzo Nobel, Inc, Davis, CA, ⁴CRINA S.A., Gland, Switzerland.

Objectives of this trial were to test two levels CRINA RUMINANTS (CRINA) fed in a TMR to continuous culture fermenters and to lactating cows. The TMRs used were identical across treatments for fermenters and cows except for the inclusion of CRINA. TMR was formulated for a high producing cow to meet NRC requirements (2001). CRINA inclusion was at 1.2 g/cow/d for the treatment group, which was equivalent to 4mg/d in the fermenters. Inoculum for the fermenters was obtained from cows in the production trial. An additional fermenter treatment containing 12mg/d CRINA was also evaluated. In fermenters, pH tended to be higher with increasing CRINA and was higher for CRINA diets than the control (P<.08). Concentrations and molar proportions of acetate, propionate, valerate, isovalerate and the A:P were either significantly, or tended to be lower for fermenters supplemented with 4 mg/d CRINA. Nutrient digestibility was not affected, however, there was a trend (P>.15) for increased NDF digestibility in CRINA treatments versus the control. There was a trend (P<.09) for CRINA diets to have higher bacterial protein synthesis versus control. A commercial dairy herd was used to test CRINA supplementation on milk yield for a four month period. All cows in the high group pen at the farm were split into two sub pens and fed identical diets except that Pen A contained CRINA at the rate of 1.2 g/cow/d while Pen B contained no CRINA. Daily milk yield and weekly composition were collected for every cow. Milk samples were assayed by DHIA. Results for cows that began and finished the trial during the feeding period showed that those in Pen A (n=82) produced 3.6 lb/day more milk (p<0.05) than Pen B (n=88). For all cows, including those that were in trial pens for only part of the trial period, the milk increase by cows in Pen A was 1.4 lb/day (p<0.07; n= 248 and 257 in CRINA supplemented and control group, resp.). No differences in milk composition were observed. CRINA RUMINANTS can improve milk yield in cows, which can be explained by modification of rumen microbial populations.

Key Words: Essential Oils, Dairy Cows, Continuous Culture Fermentation

W87 Milk production and milk fatty acid profiles of cows fed different carbohydrate sources and soybean oil. E. C. Eifert^{*1,2}, R. P. Lana^{1,2}, J. M. S. Campos¹, D. P. D. Lanna³, P. B. Arcuri⁴, M. I. Leo¹, and R. D. Valadares¹, ¹Universidade Federal de Viosa-DZO, Viosa, MG, Brazil, ²CNPq, Brasília, DF, Brazil, ³LNCA-ESALQ/USP, ⁴CNPGL-EMBRAPA.

This study was carried out to evaluate the effect of different carbohydrate sources and soybean oil supplementation on milk production and fatty acid profiles of lactating dairy cows. Twelve Holstein cows, purebred and crossbred with Zebu, were used in a 3x3 Latin square design with four replicates. The treatments consisted of 55% of corn silage and 45% of concentrate with corn (CN), wheat bran (WB) or citrus pulp (CP) as energy sources, and associated with soybean oil in the concentrate (0 and 2.25%). Dry matter intake (18.4 kg/day) and milk

production (23.5 kg/day) did not differ among CN, WB or CP, but WB diets showed the lowest total NDF and organic matter digestibility (P<.05). Microbial synthesis was not affected by carbohydrate source or soybean oil (239.4 g microbial N/day). Soybean oil-containing diets showed lower DMI (17.8 vs 19.0 kg/day), milk lactose (4.33 vs 4.49%) and milk fat (3.13 vs 3.34%) than did control diets (P<.07). Soybean oil-containing diets increased the milk protein:fat ratio (1.00 vs 0.94) (P<.05). Fatty acid profile was not influenced by carbohydrate source, but concentration of short and medium chain fatty acids decreased by 27.3 and 26.8%, respectively; while concentration of long-chain fatty acids increased by 44.5% in cows fed soybean oil (P<.01). Soybean oil also increased *cis-9 trans-11* CLA by 230% and *trans-C18:1* by 229% (P<.01). *Trans-11 C18:1* was the main *trans-C18:1* isomer and an interaction between oil and carbohydrate source was observed for *trans-10 C18:1* (P<.05). This fatty acid was similar in CN, WB or CP, but in combination with soybean oil, concentration of *trans-10 C18:1* in CN and WB diets was greater than in CP diet, indicating bio-hydrogenation activities through different pathways. The elevated *trans-10 C18:1* content was consistent with reduction in milk fat and CP had higher potential than CN or WB to supply *trans-11 C18:1* for endogenous CLA synthesis by Δ^9 -desaturase.

Key Words: Bio-Hydrogenation, CLA, Fatty Acids

W88 Effects of increasing doses of a specific blend of essential oils on rumen nitrogen metabolism and fermentation profile in continuous culture system. L. Castillejos¹, S. Calsamiglia^{*1}, A. Ferret¹, and R. Losa², ¹Universidad Autonoma de Barcelona, Spain, ²AKZONOBEL/CRINA SA, Gland Switzerland.

Eight dual flow continuous culture fermenters (1320 ml) were used in two periods (6 d of adaptation and 3 d of sampling) to study the effects of increasing doses of a specific blend of essential oils (EOB, CRINA RUMINANTS) on rumen nitrogen metabolism and fermentation profile. Temperature (39C), pH (6.4), and liquid (10%/h) and solid (5%/h) dilution rates were maintained constant. Fermenters were fed 95 g/d of DM of a 60 to 40 forage to concentrate diet (18% CP; 30.2% NDF) in three times per day. Treatments were: Control (no EOB), D1 (5 mg/L of EOB), D10 (50 mg/L of EOB) and D100 (500 mg/L of EOB), and were randomly assigned to fermenters within periods. A sample was taken daily 2 h after the morning feeding for the determination of ammonia N and volatile fatty acids (VFA). During the last 3 days, samples were taken at 0, 2, 4 and 6 h after the morning feeding and analyzed for peptide, aminoacid and ammonia N concentrations. Total VFA (mM) tended (P = 0.06) to be higher for D1 (129.1) compared with Control (120.4). Acetate proportion (mol/100mol) tended (P = 0.06) to be higher for D1 (63.6) compared with Control (58.0). Propionate proportion (mol/100mol) was lower for D1 (16.9) and D10 (17.5) compared with Control (20.6). Valerate proportion (mol/100mol) was lower for D1 (3.25) compared with Control (4.22). Branch-chained VFA concentration (mM) was higher for all EOB treatments (average of 5.19) compared with Control (3.10). The average peptide N concentration (mg/100ml) was lower for D1 (4.88) compared with Control (5.98). The aminoacid and ammonia N concentrations were similar across treatments. The treatment with 5 mg/L of EOB increased by 7% total VFA, increased by 5 percentage units the acetate proportion, and decreased by 4 percentage units the propionate proportion. The decrease in peptide N concentration suggested that the treatment with 5 mg/L of EOB inhibited proteolysis.

Key Words: Essential Oil Blend, Rumen Microbial Fermentation, Nitrogen Metabolism

W89 Effect of essential oils on ruminal fermentation *in vitro*. A. N. Hristov, J. K. Ropp, and A. Melgar*, Department of Animal and Veterinary Science, University of Idaho, Moscow.

The objective of this study was to investigate the effect of essential oils (EO) on ruminal fermentation *in vitro*. Ruminal fluid enriched with particle-associated microorganisms was recovered from two lactating dairy cows fed an alfalfa hay/cereal silage/concentrate diet one hour before feeding. The *in vitro* media contained: ruminal inoculum, reducing agent, (¹⁵NH₄)₂SO₄, and nutrients (glucose, maltose, sucrose, soluble starch, crystalline cellulose, and hydrolyzed and native casein) dissolved in buffer. Three, 4-h incubations were conducted within a 2-wk period. Forty EO were tested at two concentrations, 10 and 100 ppm (final media concentration). Monensin-Na (M), and sodium laurate (SL)

were also incubated at 5 ppm and 0.2%, respectively. Compared to a Blank (no addition of EO), SL increased ($P < 0.001$) media pH (6.66 vs. 6.82, respectively). A number of EO reduced ($P < 0.05$) media pH. Both, SL and M reduced ($P < 0.001$) ammonia concentration compared to the Blank (1.81, and 1.89 vs. 2.30 mmol/L, respectively). Compared to the Blank and across application levels, only one of the tested EO slightly reduced ($P = 0.058$) ammonia concentration to 2.11 mmol/L. Many EO increased ($P < 0.05$) media total VFA concentration by 8 to 13%. SL, but not M, reduced ($P < 0.05$) total VFA concentration (74.9 vs. 83.2 mmol/L, respectively). Acetate and propionate concentrations were reduced ($P < 0.05$) by SL compared to the Blank. Several EO and SL increased ($P < 0.05$) acetate to propionate ratios from 1.93 (Blank) to 2.05-2.07; M had no effect ($P > 0.05$) on this variable. ¹⁵N-enrichment of ammonia N was greater ($P < 0.001$) in SL and M compared to the Blank (by 38 and 28%, respectively), suggesting reduced deamination of amino acids with the former treatments. EO had no effect on this variable. The EO tested in this experiment did not affect ammonia concentration *in vitro*, but some oils increased total VFA concentration and acetate to propionate ratio and reduced media pH.

Key Words: Essential Oil, Rumen Fermentation, Ammonia

W90 The conjugated linoleic acid and ω -3 fatty acids in milk and cheese from cows fed calcium salts of fish oil alone or in combination with soybean products. S. L. Allred*¹, T. R. Dhiman¹, C. P. Brennan¹, R. C. Khanal¹, D. J. McMahon¹, and N. D. Luchini², ¹Utah State University, Logan, ²Bioproducts, Inc., Fairlawn, OH.

Twenty Holstein cows were used in a complete randomized block design to determine the influence of feeding a total mixed ration (CTL), CTL diet supplemented with 2.7% calcium salts of fish oil (FO), FO plus 5% extruded full-fat soybeans (FOESM), or FO plus 0.75% soybean oil (FOSO), on fatty acid composition and flavor characteristics of milk and cheese. Total fatty acid intake was 0.93^b, 1.28^a, 1.42^a, and 1.29^a kg/day for CTL, FO, FOESM, and FOSO diets, respectively. There was no difference in feed DM and NEL intakes, or in milk yield or milk composition among treatments. Milk fat conjugated linoleic acid (CLA) and *trans*-11 C_{18:1} (TVA) contents for cows fed CTL, FO, FOESM, and FOSO diets were 0.61^b, 1.27^a, 1.44^a, and 1.82^a; and 3.29^c, 4.66^{bc}, 6.30^{ab}, and 7.80^a % of fat, respectively. Total ω -3 fatty acid content was 0.62^b, 0.69^a, 0.69^a, and 0.67^{ab} % of fat for CTL, FO, FOESM, and FOSO diets, respectively. The ratio between ω -3 and ω -6 fatty acids was not different among diets. Concentrations of CLA and TVA in cheese were 0.63^d, 1.14^c, 1.41^b, and 1.70^a; and 2.98^d, 4.91^c, 6.00^b, and 7.00^a % of fat for CTL, FO, FOESM, and FOSO diets, respectively. Total ω -3 fatty acid contents in cheese were 0.62^b, 0.73^a, 0.74^a, and 0.71^a % of fat for CTL, FO, FOESM, and FOSO diets, respectively. No difference in flavor scores was detected by a trained sensory panel for milk (n = 7) and cheese (n = 10), except for acid flavor in cheese ($P < 0.05$), which was 4.30^{ab}, 3.87^b, 4.43^a, and 4.39^{ab} for CTL, FO, FOESM, and FOSO diets, respectively. Results from the present study suggest that calcium salts of fish oil alone or in combination with soybean products can be used to enhance the CLA and ω -3 fatty acid content of milk and cheese with minimal negative impact on flavor characteristics.

Key Words: Milk and Cheese, Conjugated Linoleic Acid, ω -3 Fatty Acids

W91 Evaluation of the degree of rumen inertness and bioavailability of *trans*-10, *cis*-12 CLA in a lipid encapsulated supplement. A. L. Lock*¹, J. W. Perfield II¹, D. E. Putnam², and D. E. Bauman¹, ¹Cornell University, Ithaca, NY, ²Balchem Encapsulates, New Hampton, NY.

The efficacy of *trans*-10, *cis*-12 conjugated linoleic acid (CLA) in reducing milk fat synthesis in dairy cows has been well documented. CLA has potential as a management tool for reducing milk fat in a controlled manner, which may be useful during times of inadequate nutrient intake or in areas where a milk fat quota exists. In order to maximize CLA absorption it must be protected from biohydrogenation by bacteria in the rumen. This requires a rumen-protected product that is optimized for protection from metabolism in the rumen as well as subsequent bioavailability in the small intestine. The objective of this study was to evaluate the degree of rumen inertness and bioavailability of CLA in a lipid encapsulated supplement (LE-CLA). Three rumen fistulated lactating Holstein cows (212±31DIM) were randomly assigned in a 3 X 3 Latin

square experiment. Treatments were: 1) no supplement (control), 2) rumen infusion of LE-CLA (80 g/d), and 3) abomasal infusion of LE-CLA (80 g/d). CLA treatments were designed to provide 7.8 g/d of *trans*-10, *cis*-12 CLA which was either infused into the rumen or abomasum four times a day in equal amounts. Treatment periods were 5 d with a 7 d interval between periods. Milk yield, DMI and milk protein yield were unaffected by treatment. Rumen and abomasal infusions of LE-CLA significantly reduced milk fat content by 13% and 29%, and milk fat yield by 11% and 28% ($P < 0.001$), respectively. The reduction in milk fat yield was due to decreases in both de novo fatty acid synthesis and uptake of preformed fatty acids with the pattern of reductions similar for rumen and abomasal infusions. Milk fat content of *trans*-10, *cis*-12 CLA was <0.01, 0.06 and 0.15 g/100 g of fatty acids for the control, rumen and abomasal treatments, respectively ($P < 0.001$). In conclusion, both rumen and abomasal infusions of a LE-CLA supplement caused a reduction in milk fat content and yield while having no effect on DMI, milk yield or other milk components.

Key Words: Conjugated Linoleic Acid, Milk Fat Depression, Rumen Protection

W92 Milk fat conjugated linoleic acid in selected commercial dairies of Utah and Idaho. R. C. Khanal* and T. R. Dhiman, Utah State University, Logan.

A two-year study was conducted to investigate the conjugated linoleic acid (CLA) content of milk on 2 commercial dairies (Farms A and B) in Utah and 2 dairies in Idaho (Farms C and D). Farms A, B, C, and D had 80, 150, 400, and 500 milking cows, respectively. Cows on farms A and B were grazed on pasture and supplemented with 7.0 kg/cow per day of grain in summer and were fed conserved forage and grain during winter. Cows on Farm C were fed a total mixed ration (TMR) containing conserved forage and grain year-round, with 10% of diet DM as fresh cut grass during summer. Cows on Farm D were fed TMR during winter. During the summer one-third of the cows on Farm D grazed on pasture and were supplemented with TMR and the remaining cows received only TMR. Milk samples were collected every month from the bulk tank and twice per year (during summer and winter) from selected individual cows (15% of the milk cows on the farm or a minimum of 20 cows) for fatty acid analysis. Milk CLA contents (C_{18:2} *cis*-9, *trans*-11 isomer) were 0.66^b, 0.75^a, 0.40^d and 0.58^c % for bulk tank samples and 0.73^a, 0.75^b, 0.43^c and 0.55^a % of fat for individual cow samples from Farms A, B, C, and D, respectively. Milk fat CLA content was higher ($P < 0.01$) during summer compared with winter (0.79^a and 0.42^b for bulk tank and 0.78^a and 0.40^b % of fat for individual cows during summer and winter, respectively). Milk fat CLA contents for individual cows varied from 0.16 to 2.22% of fat across farms. Individual cow variation in milk CLA content was larger for Farms A and B than for Farms C and D. Bulk tank CLA content of milk varied from 0.27 to 1.35% of fat across farms. Total daily yields of CLA/cow were higher on Farms A and B even though total milk yield was less than that of cows on Farms C and D. Results from this study suggest that CLA levels of milk from dairies that utilized some grazing practices had 47% higher CLA than dairies with no grazing. In addition, individual cow variation in milk CLA content is higher when cows are grazing on pasture.

Key Words: Conjugated Linoleic Acid, Cow, Pasture

W93 Synthesis of *trans* fatty acids and isomers of conjugated linoleic acid in the rumen of cows fed grass silage based diets supplemented with incremental levels of sunflower oil. K. J. Shingfield*¹, S. Ahvenjärvi¹, V. Toivonen¹, P. Huhtanen¹, and M. J. Grönari², ¹MTT Agrifood Research Finland, Jokioinen, ²University of Helsinki, Finland.

Based on the potential benefits of conjugated linoleic acid (CLA) for human health there is a need to develop effective strategies for enhancing CLA concentrations in milk and meat. *Cis*-9, *trans*-11, the predominant CLA isomer in ruminant tissues, is derived from two sources; ruminal biohydrogenation of C_{18:2} (n-6) and endogenous conversion of *trans*-11 C_{18:1}. Most evidence to date suggests that endogenous synthesis is the most important source of CLA. Four lactating cows fitted with rumen cannula were used in a 4 x 4 Latin square with 14 d experimental periods to examine the effects of dietary C_{18:2} (n-6) supplementation on ruminal *trans* C_{18:1} and CLA synthesis. Cows were offered a basal diet consisting of grass silage and a cereal based-concentrate (60:40 forage:concentrate ratio, DM basis) supplemented with 0, 250, 500 or

750 g/d of sunflower oil (C, S1, S2 and S3, respectively). The flow of fatty acids leaving the rumen was assessed using the omasal sampling technique and a triple indigestible marker method. Lipid supplementation had no effect on DMI, but shifted ($P < 0.001$) rumen fermentation towards propionate at the expense of acetate, and increased linearly ($P < 0.05$) the flow of C18:0 (237, 408, 514 and 672 g/d for C, S1, S2 and S3, respectively), trans C18:1 (30, 67, 118 and 226), C18:2 (n-6) (5.5, 8.7, 8.7 and 12.5) and total CLA (2.5, 5.0, 9.7 and 12.4) entering the omasal canal. While trans-11 was the predominant isomer (15, 30, 55 and 126 g/d for C, S1, S2 and S3, respectively), the flow of all trans C18:1, including trans-10 (1.3, 4.1, 8.6 and 20.6) and trans-13/14 (4.5, 10.5, 16.9 and 22.6) were enhanced ($P < 0.05$). Cis-9, trans-11 was the most abundant CLA isomer (1.6, 3.9, 8.0 and 9.9 g/d), but sunflower oil supplementation also resulted in linear increases ($P < 0.05$) in ruminal trans-10, cis-12 CLA, trans-8, trans-10 CLA, trans-9, trans-11 CLA and trans-10, trans-12 CLA synthesis. It is concluded that ruminal synthesis is a significant source of cis-9, trans-11 CLA that can be enhanced with dietary supplements of C18:2 (n-6).

Key Words: Ruminal Biohydrogenation, Conjugated Linoleic Acid, Trans Fatty Acids

W94 Effect of fish oil and sunflower oil supplements offered alone or in varying combinations on milk fatty acid composition in cows fed maize silage based diets. K. J. Shingfield^{*1}, C. K. Reynolds¹, D. J. Humphries¹, B. Lupoli¹, V. Toivonen², A. S. Grandison³, M. J. Griinari⁴, and D. E. Beever¹, ¹Centre for Dairy Research, University of Reading, UK, ²MTT Agrifood Finland, Jokioinen, ³School of Food Biosciences, University of Reading, UK, ⁴University of Helsinki, Finland.

Based on the potential benefits of conjugated linoleic acid (CLA) for human health there is a need to develop effective strategies for enhancing CLA concentrations in milk. Five dairy cows in mid-lactation were used in a 5 x 5 Latin Square experiment with 3 week periods to examine the effects of feeding fish oil (FO) or sunflower oil (SO) separately, or in combination, on milk fatty acid composition. Cows were offered 18 kg DM/d of a TMR based on maize silage (65:35 forage:concentrate ratio; DM basis) supplemented (g/kg DM) with FO (15), [FO (15) and SO (15) (FLS)], [FO (15) and SO (30) (FMS)], [FO (15) and SO (45) (FHS)] or SO (60). Lipid supplements were fed during the last 14 d of each period. Treatments had no effect ($P > 0.05$) on DMI, milk yield or milk fat or protein content, but milk fat concentrations were low for all diets (26.3, 26.6, 24.5, 22.9 and 23.6 g/kg, for FO, FLS, FMS, FHS and SO, respectively). Levels of total CLA as determined by GLC and Ag+ HPLC were higher ($P < 0.05$) for FO, FLS and FMS than SO (2.63, 3.04, 2.87 and 1.57 g/100g fatty acids), whilst the response to FHS was intermediate (2.18). For all diets, cis-9, trans-11 was the predominant isomer of CLA (proportionately 0.84, 0.82, 0.81, 0.68 and 0.62 for FO, FLS, FMS, FHS and SO, respectively). Increasing the amount of SO in combination with a fixed amount of FO resulted in a progressive increase in milk trans-10 C18:1 content (8.6, 11.1 and 13.5 g/100g fatty acids, for FLS, FMS and FHS), but caused levels of trans-11 C18:1 to decline (5.6, 5.2 and 2.9). Levels of trans-10 and trans-11 C18:1 were 5.0 and 4.2 for FO and 11.0 and 2.1 for SO. It is concluded that sunflower oil enhances the milk CLA response to fish oil in cows fed maize silage based diets, but high levels induce shifts in ruminal biohydrogenation towards trans-10 C18:1 at the expense of trans-11 C18:1.

Key Words: Conjugated Linoleic Acid, Trans Fatty Acids, Fish Oil

W95 Effects of rumen-protected fatty acid saturation on ruminal and total tract nutrient digestion in lactating dairy cows. K. J. Harvatine* and M. S. Allen, Michigan State University, East Lansing.

Saturated and unsaturated rumen-protected fat sources were evaluated for effects on ruminal digestion kinetics, and ruminal and post-ruminal nutrient digestion. Eight early lactation ruminally and duodenally cannulated cows (77 ± 12 DIM, mean \pm SD) were used in a replicated 4x4 Latin square design with 21 d periods. Treatments were control and a linear titration of 2.5% added rumen-protected FA (RPF) varying in saturation: saturated (SAT); prilled hydrogenated free FA, Energy Booster 100[®]), intermediate mix of SAT and unsaturated (UNS; calcium soaps of long-chain FA, Megalac-R[®]), and UNS FA. Experimental diets were 40% forage and contained 27.5% NDF, 30% starch, and 2.5% rumen

available vegetable oil (13.5% cottonseed). SAT linearly decreased ruminal digestibility of DM and OM because of a linear reduction in ruminal neutral detergent fiber (NDF) digestibility. The reduction in ruminal NDF digestibility was because of a linear decrease in digestion rate and a linear increase in passage rate of potentially digestible NDF for SAT. Total-tract digestibility was not different between treatments because of compensatory post-ruminal digestion. Ruminal FA and C18 FA digestibility tended to increase linearly with UNS, and post-ruminal C18 FA digestibility increased with UNS. SAT linearly decreased ruminal OM digestibility and decreased intestinal long-chain FA digestibility, although differences in FA digestibility may be partially explained by FA intake. Addition of rumen-protected FA may not increase energy intake because of decreased DM intake and negative associative effects on ruminal digestion.

Key Words: Ruminal, Digestibility, Fatty Acid

W96 Effect of Ca salts of palm and fish oils on lactation and reproduction of dairy cows under heat stress. R. G. S. Bruno^{*1}, K. N. Galvao¹, S. O. Juchem¹, W. W. Thatcher², E. J. DePeters¹, D. Luchini³, and J. E. P. Santos¹, ¹University of California Davis, Tulare, ²University of Florida, Gainesville, ³Bioproducts, Inc, Fairlawn, OH.

Multiparous Holstein cows, 331, 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 (CaPFO; 1.5% DM), to provide equal amounts (350 g/d) of fatty acids (FA) from 20 to 130 d in milk (DIM). The Ca salt provided 18 g/d of eicosapentaenoic and docosahexaenoic FA combined. The study was conducted from May to December of 2003 and only cows calving during the hot months (May-August) were enrolled. Cows were milked 3 times daily and production of milk and milk components were measured every two weeks. All cows were subjected to the Presynch/Ovsynch protocol and timed AI was performed between 60 and 70 DIM. Pregnancy was diagnosed at 38 d after AI by ultrasound and reconfirmed 4 weeks later by palpation per rectum. Continuous and binomial data were analyzed by the MIXED and LOGISTIC procedures of the SAS (2001) program. Group DM intake averaged 25.7 kg/d. Yields (kg/d) of milk, 3.5% fat-corrected milk and milk fat did not differ ($P > 0.15$) and were (kg/d), respectively, 44.8, 45.5, and 1.58, for cows fed CaPFO, and 45.51, 46.24, and 1.62 for cows fed TA. Percent of true protein and lactose in milk were reduced ($P < 0.05$) in cows fed CaPFO (2.73% and 4.81%) compared with cows fed TA (2.76% and 4.86%), and solids nonfat tended to be reduced for CaPFO compared with TA (8.37 vs 8.45%; $P < 0.06$). Because of the lower true protein content in milk, protein yield was reduced in cows fed CaPFO (1.22 vs 1.26 kg/d; $P = 0.04$). Conception rates for cows fed CaPFO and TA were similar at d 38 (26.9 vs 25.9%; $P = 0.85$) and 60 (24.1 vs 24.5%; $P = 0.95$) after AI. Similarly, pregnancy loss from d 38 to 60 of gestation did not differ between CaPFO and TA (9.7 vs 4%; $P = 0.41$). These results suggest that feeding Ca salts of palm and fish oils did not influence lactation or reproduction of cows under heat stress, but reduced concentrations of protein, lactose and solids nonfat in milk.

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Key Words: Dairy Cows, Fatty Acids, Milk Production

W97 Modulation of bovine hepatic lipid metabolism by fatty acids. J. A. A. Pires^{*1}, R. R. Grummer¹, D. G. Mashek¹, S. J. Bertics¹, D. Pirazzi², and U. Bernabucci², ¹University of Wisconsin, Madison, ²Università della Tuscia, Viterbo, Italy.

The objective was to investigate the metabolism of different fatty acids (FA) by bovine hepatocytes cultured in monolayer. Hepatocytes were isolated from three 7 to 10 d old male Holstein calves and treated for 48h (from 20 to 68 h after seeding) with either no FA added (control) or 1 mM of palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2), linolenic (C18:3), eicosapentaenoic (C20:5), docosahexaenoic (C22:6) acid, or a physiological FA mix (NEFA; 15% C18:0, 30% C16:0, 45% C18:1, 5% C16:1, and 5% C18:2). Culture media was collected at 24 and 48h and pooled for total β -hydroxybutyric acid (BHBA) analysis. Total triglycerides (TG) was extracted from cells and quantified. Data were analyzed using Mixed Procedure of SAS. The model included fixed effect of treatment, random effect of calf, and residual error term.

Adding C16:0 or 18 carbon FA caused an increase in TG accumulation. Among 18 carbon FA, increasing unsaturation led to lower levels of TG accumulation. Incubation with C20:5 or C22:6 did not result in TG accumulation. However, adding C20:5 or C22:6 increased BHBA production relative to control, which shows that these FA were being absorbed and oxidized. C18:2 caused the lowest BHBA production of all FA treatments but TG accumulation was similar to all other C18 FA and NEFA. These results show that FA are metabolized differently by bovine hepatocytes. Treatment differences may be related to changes in cell membrane properties, differential absorption of FA, suitability of FA as substrates for enzymes or effects on gene expression of key enzymes in lipid metabolism.

	TG*	BHBA**
Control	3.15 ^{cd} ±0.19	1.37 ^d
C16:0	23.81 ^{ab} ±4.19	7.60 ^b
C18:0	37.47 ^a ±8.70	12.66 ^a
C18:1	32.48 ^a ±6.75	8.24 ^b
C18:2	23.65 ^{ab} ±3.38	2.71 ^c
C18:3	15.94 ^b ±2.01	8.53 ^b
C20:5	2.51 ^d ±0.38	7.33 ^b
C22:6	4.11 ^c ±0.63	9.74 ^{ab}
NEFA	21.62 ^{ab} ±8.33	7.28 ^b

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

*LSM ± SEM. **LSM, pooled SEM=3.96.

LSM and SEM are presented as ug/ug DNA.

Key Words: Fatty Acids, Hepatic Metabolism, Bovine

W98 Milk fatty acid composition and lactation performance of cows fed linseed oil or fish oil in combination with sunflower seeds. K. F. Kalscheur*, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings.*

This study was conducted to determine the effect of feeding linseed oil or fish oil on production of conjugated linoleic acid (CLA) in milk of cows fed sunflower seeds. Eight primiparous and four multiparous Holstein cows averaging 112 DIM were used in a 4 × 4 Latin square with 4-wk periods. Treatments were: 1) control diet (no oilseeds), 2) 2.5% fat from sunflower seeds (S), 3) 2% fat from sunflower seeds plus 0.5% fat from linseed oil (L), and 4) 2% fat from sunflower seeds plus 0.5% fat from fish oil (F). Diets were composed of a 50% (dry basis) concentrate mix, 25% corn silage, 12.5% alfalfa hay and 12.5% haylage. Cracked sunflower seeds replaced corn and soybean meal in the sunflower diets. Diets averaged 16.6% CP, 29.6% NDF, and 20.1% ADF. Ether extract and NE_L increased from 2.7% and 1.57 Mcal/kg for the control diet, to 5.1% and 1.64 Mcal/kg for the fat supplemented diets, respectively. Dry matter intake (26.9, 27.9, 24.6, and 26.0 kg/d for diets 1 through 4) did not differ ($P > 0.05$). Milk production (38.5, 39.4, 40.7, and 43.8 kg/d) was highest for cows fed F ($P < 0.05$). Milk fat percentage (3.28, 3.25, 3.23, and 2.96) was lower for cows fed F ($P < 0.01$). Addition of supplemental fat did not affect milk protein percentage, MUN, or milk component yields. Concentrations of milk *cis*-9, *trans*-11 CLA (0.53, 0.68, 0.71, and 1.35 g/100 g fatty acids for diets 1 through 4) increased with the inclusion of sunflower seeds, and was highest ($P < 0.01$) when fed with fish oil. Similarly, milk vaccenic acid (TVA) increased (0.60, 0.97, 0.91, and 2.12 g/100g fatty acids) with the addition of sunflower seeds, and was highest ($P < 0.05$) for cows fed F. Cows fed sunflower seeds with fish oil increased milk production and milk CLA and TVA more than cows fed the control or non-fish oil diets. Feeding linseed oil with sunflower seeds did not increase lactation performance or increase milk CLA or TVA.

Key Words: Conjugated Linoleic Acid, Vaccenic Acid, Milk Fatty Acids

W99 The effect of dilution rate and pH on the conversion of stable isotopically labeled oleic acid to trans monoenes in continuous cultures. A. A. AbuGhazaleh*, M. B. Riley, and T. C. Jenkins, *Clemson University, SC.*

A previous in vitro study using batch cultures of mixed ruminal microbes showed that oleic acid was converted to trans monoene isomers. This study was conducted to determine if a similar conversion can occur under different rumen environmental conditions. Four dual-flow continuous fermenters were used to determine the effects of pH and liquid dilution rates on microbial biohydrogenation of ¹³C-labeled oleic acid

to trans monoenes. A 4 × 4 Latin square design with a factorial arrangement of treatments was used, with four 11-d consecutive periods. Treatments were 1) pH 6.5 and 0.10 h⁻¹ dilution rate, 2) pH 6.5 and 0.05 h⁻¹ dilution rate, 3) pH 5.5 and 0.10 h⁻¹ dilution rate, and 4) pH 5.5 and 0.05 h⁻¹ dilution rate. Fermenters were fed twice daily (22g/d) a TMR diet consisting of 55% alfalfa, and 45% concentrate mix (DM basis). The ¹³C-labeled oleic acid (250 mg) dissolved in 5 ml of 95% ethanol was added into fermenters after the morning feeding on d-10 of each period. Samples of digesta were taken at 0 h (before adding ¹³C-labeled oleic acid) and at 24 h after adding ¹³C-labeled oleic acid. Both pH and dilution rate affected trans monoene formation from oleic acid. At pH 5.5, ¹³C enrichment was not detected on the trans double bonds between carbons 11 and 16 compared with pH 6.5. Similarly, at 0.05 h⁻¹ dilution rate ¹³C enrichment was not detected on the trans double bonds between carbons 12 and 16 compared with 0.10 h⁻¹ dilution rate. The percentage of trans-9 and 10 produced from oleic acid was not affected by pH ($P > 0.05$). The percentage of trans-6, 9, 10, and 11 produced from oleic acid was higher ($P < 0.05$) at the 0.10 h⁻¹ dilution rate compared with 0.05 h⁻¹ dilution rate. The percentage of stearic acid produced from oleic acid was not affected by dilution rate ($P > 0.05$) and it was higher ($P < 0.05$) at pH 5.5 (72%) compared with pH 6.5 (26%). The results of this study show that conversion of oleic acid to trans monoenes was reduced under low dilution rate and pH conditions.

Key Words: pH, Dilution Rate, Biohydrogenation

W100 Feeding encapsulated ground full-fat soybean or sunflower oil gel containing tocopheryl acetate to increase tocopherol and linoleic acid levels in lamb carcass. J. H. Lee^{*2,1}, S. L. Melton¹, and J. C. Waller¹, ¹University of Tennessee, Knoxville, ²Fort Valley State University, Fort Valley, GA.

This study investigated the effect of encapsulated ground full-fat soybean (EGFS) or sunflower oil gel (SOG) containing tocopheryl acetate (TA) on tocopherols and fatty acids in feeder lambs. The EGFS were prepared by ground full-fat soybean (GFS) with either acetaldehyde (AC) or diacetyl (DA) to form gels. The SOG contained sunflower oil, TA, defatted soy flour, and DA. In trial 1, lambs (n = 18) were divided into 3 groups (6 heads in 2 pens/group). Groups were fed randomly assigned diets for 9 wk: control (BD+GFS), AC (BD+EGFS-AC), and DA (BD+EGFS-DA) diets. The BD contained corn, alfalfa, and oat. Each lamb was fed daily 0.7 kg of BD and 0.5 kg of GFS to supply same amounts of tocopherols (64 IU). In trial 2, lambs (n = 24) were divided into 3 groups (2 pens of 8 lambs), and the 3 groups were fed randomly assigned diets for 12 wk: BD (control), BD (0.7 kg/lamb/d)+TA(250 IU/lamb/d), and 1/3BD+SOG (0.5 kg/lamb/d). The α-tocopherol levels of longissimus muscle (LD) and pelvic fat (PF) from each lamb in trial 1, as well as LD, gluteus medius (GM), psoas major (PM) and brisket fat (BF) from trial 2, were determined. Fatty acid compositions of LD were also analyzed. All data were analyzed as a completely random design. In trial 1, lambs fed the control diet had a lower ($P < 0.05$) level of α-tocopherol in the PF (2.1 μg/g fat) than lambs fed the AC- or DA-diet (3.0 or 3.3 μg/g fat). Compared with lambs fed the control, lambs fed the EGFS had a higher ($P < 0.05$) level of linoleic acid (18:2) in LD (6.6 vs. 4.8%). In trial 2, lambs fed the BD had lower ($P < 0.05$) levels of α-tocopherol in LD, GM, PM, and BF (3.2, 3.2, 2.2, and 3.2 μg/g, respectively) than lambs fed BD+TA (3.2, 6.1, 6.0, and 12.2 μg/g) or BD+SOG (4.2, 7.6, 7.4, and 12.6 μg/g). Compared with lambs fed BD, lambs fed BD+SOG had higher ($P < 0.05$) levels of 18:2 in LD (13.0 vs. 7.2%). The results imply that both EGFS and SOG supplements may enhance the absorption of tocopherols and increase linoleic acid levels in ruminants.

Key Words: Tocopherol, Tocopheryl Acetate, Linoleic Acid

W101 Corn silage hybrid quality effects on milk production in dairy cows. D. J. R. Cherney*, J. H. Cherney*, L. E. Chase, and W. J. Cox, *Cornell University, Ithaca, NY.*

Higher milk production is the promised outcome for selecting corn hybrids with various traits that impact forage quality. Our objective was to select a set of hybrids most likely to exhibit differences in forage quality and evaluate milk production of cows fed a high forage ration. Four hybrids were selected for the feeding trial: a leafy hybrid (Mycogen TMF 100), a brown-midrib (Mycogen BMR F407), and two hybrids with a range in fiber digestibility (Pioneer 36B08 and Pioneer 35P12). Diets were formulated to provide 1.05% of BW as forage NDF (approx.

31% NDF), and were balanced to meet or exceed NRC requirements. Fifty-six cows were fed for 56 days. Dry matter intake of cows fed BMR and leafy hybrid TMR was higher than those fed the other hybrids. Differences in milk production reflected the differences in intake. Cows fed BMR (41.7 kg d⁻¹) and leafy hybrid (42.1 kg d⁻¹) TMRs were not different from each other in milk production, but had higher (P<0.05) milk production than 35P12 (39.2 kg d⁻¹) and 36B08 (39.0 kg d⁻¹). Higher intake by cows fed BMR TMR than 35P12 and 36B08 TMRs is likely the result of higher digestibility. While the leafy hybrid tended to be higher in digestibility than 35P12 and 36B08, it is likely that lower forage:concentrate ratio of the leafy hybrid TMR than the other TMR also contributed to its higher intake. Ruminal concentrations of propionate were higher in cows fed BMR than those fed other hybrids, which could also result in higher milk production. Corn silage hybrids selected for improved forage quality can result in higher milk production by cows fed the improved hybrids in high forage diets.

Key Words: Corn Silage, Digestibility, Milk Production

W102 Variation throughout lactation and between herds in maintenance energy expenditures of dairy cows estimated from energy balance data. J. L. Ellis*, F. Qiao, and J. P. Cant, *The University of Guelph, Ontario, Canada.*

Maintenance energy expenditures and between-herd variation in maintenance energy expenditures for Holstein dairy cows were evaluated from average weekly NE balance estimates in 21 herds throughout lactation. NE balance was calculated from observed intake, growth and milk production data according to NRC as $DMI \cdot NE(l) \text{ feed} - FCM \cdot 0.749 \cdot 0.08 \cdot BW^{0.75}$. For first-lactation cows, a modified version of the NRC growth expenditure equation was added into the energy balance equation: $0.0103 \cdot (BWT \cdot 0.96)^{0.75}$. Bodyweight was predicted as 0.203 times NE balance if the balance was negative and 0.195 times balance if positive. When the NRC maintenance parameter 0.08 Mcal/kg BWT^{0.75} was used in energy balance calculation, bodyweight was over-predicted, with an increasing difference between predicted and observed bodyweight as lactation progressed. The maintenance parameter that resulted in the least residual sum of squares (LSS) for bodyweight prediction throughout lactation for each data set was determined. The average LSS maintenance parameter for the 21 data sets was 0.096 Mcal/kg BWT^{0.75}, with a standard deviation of 0.0182. Average maintenance energy parameters estimated weekly for an NE balance of 0 Mcal/d were determined and plotted against week of lactation. Average maintenance energy expenditure at the onset of lactation was approximately 0.085 Mcal/kg BWT^{0.75}. This value increased until week 15 of lactation where it plateaued at approximately 0.100 Mcal/kg BWT^{0.75}. At #8805 40 weeks of lactation it decreased. Standard deviation between data sets of weekly maintenance parameter estimates throughout lactation was large but consistent at approximately 20% of the mean. In conclusion, maintenance energy expenditures during lactation appear to vary considerably, but are higher than the conventional 0.08 Mcal/kg BWT^{0.75}, and expenditures during lactation appear to change, increasing up to approximately week 15 of lactation, maintaining an elevated level until approximately week 40 of lactation and then declining again.

Key Words: Maintenance Energy Expenditures, Energy Balance, Lactation

W103 Effect of an amino polysaccharide on production and composition of milk of Holstein and Jersey cows in México. G. González-Luna¹, J. Sánchez-Meraz¹, S. S. González*¹, J. Pinos-Rodríguez², R. Bárcena-Gama¹, Ma. E. Ortega-Cerrila¹, and S. Infante-Gil¹, ¹*Colegio de Postgraduados, Mexico*, ²*Universidad Autónoma de San Luis Potosí, Mexico.*

The main objective of this research was to determine the effect of an amino polysaccharide (Aminoglucolite, Química Foliar, México) on milk production and composition of Holstein and Jersey cows in México. Two trials were performed, one using Jersey cows at San Carlos ranch, State of San Luis Potosí, and the second with Holstein cows at Ojo de Agua ranch, State of Guanajuato. Trial 1 lasted 56 d with two groups of 30 cows each; days on milk (used as a covariable) were 89 d for treated and 74 d for control cows; a complete mixed ratio (50:50 forage:concentrate) was used. Trial 2 lasted 60 d with two groups of 25 cows each; a complete mixed ratio (70:30 forage:concentrate) was used. For both trials, treatments were 0 (control) or 40 g Aminoglucolite/d/cow (mixed with the concentrate); experimental design was completely randomized and

data were analyzed using repeated measurement procedure (SAS), and covariance analysis. In trial 1, Aminoglucolite (vs control; P<0.10) increased milk production (31.9 vs 26.3 L/d), protein (4.1 vs 3.9% at 14 d; 4.2 vs 3.9% at 42 d), lactose (5.1 vs 4.6% at 56 d), non-fat solids (9.7 vs 9.4% at 14 d; 9.7 vs 9.5% at 42 d), but it decreased milk fat (5.4 vs 4.7%), and urea-N (8.4 vs 13.8 mg/dL). In trial 2 (vs control), Aminoglucolite increased fat corrected milk (23.4 vs 20.8 L/d; P<0.05) and solid corrected milk (20.7 vs 19.0 L/d; P<0.10) in the sixth week; there were no differences (P>0.10) for concentration of fat (%), protein (%), lactose (%), nonfat solids (%), and urea-N (mg/dL) in milk. Somatic cell count (SCC) was decreased by Aminoglucolite: 944 000 to 555 000/mL in trial 1, and 615 000 to 266 000/mL in trial 2. Results suggest that addition of this amino polysaccharide to dairy cows diets may improve milk production and composition, and decrease SCC.

Key Words: Amino Polysaccharide, Milk Production and Composition, Dairy Cows

W104 Replacing chopped alfalfa hay with alfalfa silage in barley grain and alfalfa based total mixed rations for lactating dairy cows. J. C. Plaizier*, *Department of Animal Science, University of Manitoba, Canada.*

The effects of replacing chopped alfalfa hay with alfalfa silage in a fine barley grain and alfalfa based total mixed ration (TMR) were evaluated using 12 multiparous Holstein cows in a 3 x 3 Latin square design. Diets contained (DM basis) 53.0% commercial energy supplement, 10.3% commercial protein supplement, and 9.7% corn silage. Diets varied in inclusion of chopped alfalfa hay and alfalfa silage, and contained either 20.0% chopped alfalfa hay and 7.0% alfalfa silage (H), 10.0% chopped alfalfa hay and 17.0% alfalfa silage (HS), or 27.0% alfalfa silage (S). Rumen fluid was collected using an oral probe between 4 and 5 hr after feeding. Contents of protein and fibre did not differ among diets. Replacing chopped alfalfa hay with alfalfa silage decreased dietary dry matter (DM), and increased dietary soluble protein (SP). Replacing chopped hay with silage reduced the proportion of TMR passing through the 8 and 19 mm screens of the Penn State Particle Separator (PSPS) from 27.6 to 37.9%, increased the physical effective NDF calculated as the proportion of dietary NDF retained by the two screens of the PSPS (peNDF_{NDF}), from 13.3 to 15.6% DM, and increased the proportion of DM retained by a 1.18 mm screen after dry sieving multiplied by dietary NDF (peNDF_{>1.18}) from 23.4 to 25.6 %DM. Proportions of TMR retained by the PSPS screens were lower than recommended. Replacing chopped alfalfa hay with alfalfa silage did not affect dry matter intake, rumen pH, rumen VFA, blood lactate, milk fat, and milk protein, but decreased blood glucose, tended to increase blood urea and numerically decreased milk yield. A wider range in peNDF_{NDF} and peNDF_{>1.18}, and a higher inclusion of corn silage might have resulted in greater differences in rumen fermentation and milk production among diets. The pH of rumen fluid samples varied from 5.90 to 5.98, and milk fat percentage varied from 2.50 to 2.60% among diets. These values suggest that subacute ruminal acidosis (SARA) was induced by all diets.

	Diet H	Diet HS	Diet S	SE	P
DM, %	71.4	63.4	57.3	0.75	
CP, %DM	20.5	20.5	20.7	0.39	
SP, % DM	5.5	6.5	7.7	0.23	
NDF, %DM	34.6	33.9	34.6	1.46	
Retained by PSPS screens, %	27.6 ^c	33.4 ^b	37.1 ^a	0.63	**
peNDF _{NDF} , %DM	13.3 ^b	15.1 ^a	15.6 ^a	0.61	*
peNDF _{>1.18} , %DM	23.4 ^b	24.0 ^b	25.6 ^a	0.32	*
DMI, kg d ⁻¹	23.1	22.0	22.2	1.04	NS
Rumen pH	5.90	5.99	5.98	0.05	NS
Blood glucose, mM L ⁻¹	4.41 ^a	4.37 ^a	4.17 ^b	0.10	*
Blood urea, mM L ⁻¹	6.89	7.29	7.74	0.46	
Milk yield, kg d ⁻¹	39.0	38.3	37.6	0.45	NS
Milk fat, %	2.50	2.63	2.60	0.13	NS
Milk protein, %	3.17	3.16	3.15	0.08	NS

** = P < 0.01, * = P < 0.05, = P < 0.10, NS = not significant

Key Words: Physically Effective NDF, Sub-Acute Ruminal Acidosis, Dairy Cows

W105 Soybean hulls and corn gluten feed for replacing corn silage neutral detergent fiber in total mixed rations of lactating cows. M. Lima^{*1}, L. G. Nussio², and W. Mattos², ¹Universidade Federal de Goiás, Escola de Veterinária, DPA, Goiania, GO, Brazil, ²Escola Superior de Agricultura Luiz de Queiroz, Padua Dias, Praticaba, SP, Brazil.

Four ruminally and duodenally cannulated Holsteins cows were used in a 4 x 4 Latin square design with 14-d periods to evaluate fiber effectiveness of pelleted soybean hulls (PSH) and corn gluten feed (CGF). Four isonitrogenous and isoenergetic diets were formulated, and low (LF) and high forage (HF) diets [14% and 22% of dietary DM from corn silage (CS), respectively] were compared to diets formulated to contain 14% CS NDF plus 8% of DM from PSH NDF or CGF NDF. Dry matter, CP and NDF were 28.2%, 9.2% and 44.5%; 88.8%, 10.3% and 68.2%; 89.1%, 27.2% and 38.8%, respectively for CS, PSH and GGF. The NDF intake was lower ($P < .05$) for cows fed LF (3.52 kg/d) diets than those fed HF, PSH and CGF diets (4.55 kg/d). Dry matter intake (16.9 kg/d), milk yield (19.9 kg/d) and milk crude protein (3.17%) did not differ among diets, but milk fat was higher for cows fed HF (3.80%) and CGF (3.70%) diets ($P < .05$) than those fed LF (3.27%) and PSH (3.17%) diets. Fat correct milk (3.5%) was significantly lower ($P < .05$) for cows fed the PSH (18.3 kg/d) diet than those fed HF and CGF diets (20.8 kg/d). Mean rumen pH was higher ($P < .05$) for cows fed HF (5.95) than those fed the other diets (5.74). Total VFA concentration did not differ among cows fed experimental diets, but propionic acid (mol/100 ml) was higher ($P < .05$), and acetic acid (mol/100 mol) and acetate:propionate ratio were lower ($P < .05$) for those fed PSH and CGF diets than those fed the HF diet. Ruminating (min/d and min/kg of NDF) and chewing (min/d and min/kg of NDF) activities were lower ($P < .05$) for cows fed the PSH and CGF diets than those fed LF and HF diets. Rumen mat consistency (cm/s) was also lower ($P < .05$) for cows fed PSH and CGF diets than those fed HF diet. Under our condition, PSH NDF or CGF NDF were not as effective as CS NDF to keep mean rumen pH and chewing activities, and these responses can increase the risk of acidosis for cows fed PSH and CGF diets.

Key Words: Fiber Effectiveness, Mean Rumen pH, Chewing Activities

W106 Effects of dietary forage and non-fiber carbohydrate concentrations on apparent B-vitamin synthesis in dairy cows. E. C. Schwab^{*1}, C. G. Schwab^{*2}, C. L. Girard³, R. D. Shaver¹, D. E. Putnam⁴, and N. L. Whitehouse², ¹University of Wisconsin, Madison, ²University of New Hampshire, Durham, ³Dairy and Swine R&D Center, AAC, QC, Canada, ⁴Balchem Encapsulates, New Hampton, NY.

Eight Holstein cows (four primiparous, four multiparous) were fitted with ruminal and duodenal cannulas to test the effects of dietary forage (F) and NFC concentrations on B-vitamin apparent synthesis (AS). Cows were used in a replicated 4x4 Latin square design balanced for carryover effects with a 2x2 factorial arrangement of treatments. Each square contained two multiparous and two primiparous cows and periods were 21 d in length. Experimental diets with 35 or 60% (DM basis) forage (corn silage, alfalfa hay, and grass hay) were formulated to contain either 30 or 40% NFC (DM basis). The concentrate portion of the diets was composed of varying proportions of soybean hulls, beet pulp, corn grain, rolled barley, soybean meal, blood meal, Smartamine-M[®], vitamins, and minerals. Apparent B-vitamin synthesis is defined as the difference between duodenal vitamin flow and vitamin intake. This estimate does not consider potential ruminal microbial metabolism (use or destruction) or ruminal absorption of the vitamins. There was a significant F effect on AS for all B-vitamins except pyridoxal (PAL). Apparent synthesis of B-vitamins was largely unaffected by NFC content, however AS of B₁₂ and PAL were both influenced by dietary NFC content. A FxNFC interaction existed only for thiamin AS. Negative AS values for pyridoxine (PYR) suggest that this form of vitamin B₆ was either ruminally destroyed or utilized, absorbed through the rumen wall, or converted to another B₆ form.

Item	Diets					F	Effect (P<) ⁵	
	3530	3540	6030	6040	SEM		NFC	FxNFC
Thiamin AS mg/d	70	55	48	53	6	0.01	NS	0.02
Folic acid AS mg/d	20	23	15	18	2	0.01	NS	NS
B ₁₂ AS mg/d	117	84	83	63	6	<0.01	<0.01	NS
PAM ⁶ AS mg/d	50	46	40	43	4	<0.01	NS	NS
PAL AS mg/d	6	15	7	15	3	NS	<0.01	NS
PYR AS mg/d	-21	-24	-29	-27	3	0.01	NS	NS

⁵NS=not significant ($P < 0.05$)⁶PAM=pyridoxamine

Key Words: B-Vitamin, Synthesis, Cow

W107 Effects of physically effective NDF on chewing activity and rumen pH of dairy cows fed diets based on corn silage. W. Z. Yang^{*} and K. A. Beauchemin, *Research Center, Agriculture and Agri-Food Canada, Lethbridge, AB.*

A study was conducted to investigate the effects of physically effective (pe) NDF content of dairy cow diets containing corn silage on chewing activity and rumen pH. The study was designed as a double 3 x 3 Latin square using six lactating dairy cows with ruminal cannulas. Three levels of dietary peNDF (high, medium and low) were compared. The three levels of peNDF were obtained using corn silage as originally prepared, corn silage rechopped once, or corn silage rechopped twice. The peNDF content of the diets was determined as the proportion of the TMR (as-fed) retained on the 0.75" and 0.31" screens of the Penn State Particle Separator multiplied by dietary NDF content (DM basis). The peNDF contents were 11.5, 10.3 and 8.9%, for the high, medium and low peNDF diets, respectively. Ruminating time (494, 472 and 441 min/d, for high, medium or low, respectively) was linearly affected by intake of peNDF. Eating time (273, 315 and 258 min/d, for high, medium or low, respectively) and total chewing time (767, 787 and 700 min/d for high, medium or low, respectively) were quadratically increased with increasing peNDF intake. Mean pH, area between the curve and pH 5.8 or 5.5, and time that pH was below 5.8 or 5.5, were not affected by peNDF intake. Intake of peNDF was not correlated to eating time but was correlated to ruminating time ($r = 0.49$, $P < 0.05$). In contrast, mean rumen pH was negatively correlated to intake of peNDF ($r = -0.39$, $P < 0.15$) and ruminating time ($r = -0.45$, $P < 0.15$). These results indicate that increasing the peNDF content of diets increases chewing time. However, increased chewing time does not always improve rumen pH status. Although increasing chewing time is expected to increase salivary secretion, the increase may not fully overcome the effects of feed digestion and the production of fermentation acids that lower rumen pH. Models that predict rumen pH need to include both peNDF and fermentable OM intake.

Key Words: Physically Effective NDF, Chewing, Rumen pH

W108 Effect of physical and heat processing of cottonseed on chewing activity of Holstein dairy cows. A. R. Foroughi^{*}, A. A. Naserian, R. Valizadeh, and M. Danesh mesgaran, *Ferdowsi University of Mashhad, Tehran, Iran.*

Based on chewing response, whole cottonseed (WCS) appears to be the most effective fiber source from byproduct feeds. Eight multiparous Holstein dairy cows averaging 84.50±10.34 days in milk and 36.10±4.46 milk yield (MY) were used in a 4 x 4 Latin Square design. Cows were divided into four dietary treatment groups. Dietary treatments were 1) WCS; 2) ground cottonseed; 3)GCS heated in 140°C and steeped for 2.5 minute (GHCS1); or 4) GCS heated in 140°C and steeped for 20 minute (GHCS2). Total mixed diets were fed individually free choice twice daily. Diets were formulated to contain 20% alfalfa hay, 17% corn silage, 14% different processed cottonseed and 49% concentrate and had the following composition, dry matter 79.5%, NDF 35.2%, CP 18.5% and NEL 1.58 (Mcal/KgDM). Each period consisted of 21 days and the last 7 days were used for dry matter intake(DMI). Chewing activity

were estimated through a visual observation method at 5-minute intervals during 24h at 18d of each period. The mean DMI was significantly ($P < 0.01$) affected by diets and in treatments of 1,2,3 and 4 were 25.97, 27.24, 27.63, and 27.63 (kg/d), respectively. The mean rumination times between treatments (min/kg NDF intake) were significantly different and for treatments 1,2,3 and 4 were 54.02, 45.63, 44.24, and 46.97, respectively. This represented a 15% decrease between 1 and 2. However, chewing activity was similar for four treatments averaging 279 min/24h. Significant differences were not observed in eating activity min/24h and min/kg NDF Intake and ruminating activity (min/24h), Grinding and heat treatment of cottonseed did not affect of chewing activity of dairy cows.

Key Words: Whole Cottonseed, Grinding and Heat Treatment, Chewing Activity

W109 Relationship between TMR, corn silage particle size and manure evaluation in dairy cows. G. Mancin¹, V. Dell'Orto², and G. Savoini*², ¹Dept. of Morphology, Biochemistry, Physiology and Animal Productions University of Messina, Italy, ²Dept. of Veterinary Sciences and Technologies for Food Safety, University of Milan, Italy.

The aim of the trial was to study the correlation between TMR, corn silage particle size and manure evaluation in order to give some useful tools to dairy farmers to improve milk production efficiency. Five dairy farms were involved in the trial that lasted 60 days. TMR and corn silage particle size were evaluated every two weeks by Penn State Particle Separator (PSPS). Ten fresh cows per farm were selected for manure appearance and particle size evaluation. Faecal samples were collected every two weeks and rinsed with water into a strainer with 1.6 mm openings. Faecal undigested fractions were classified by score from 1 (no large fibre particles, no ground grain) to 5 (large fibre particles, abundant ground grain). Data were analyzed by Pearson correlation. TMR average particle size distribution was quite different compared to PSPS guidelines, indeed the percentage of TMR retained on the upper sieve (15.97%) was greater compared to PSPS guidelines, this is probably due to the high quantity of forage used in our rations (average NDF=37,4%_{ss}) and greater length of hay and grass silage particles. Corn silage particle size distribution was in accordance with the PSPS guidelines, for this reason significant positive correlations were observed between corn silage and TMR percentages retained on mid, low and bottom sieves. Positive correlations were observed among ration NDF and TMR particles retained on upper and middle sieves ($r=0.19$; $r=0.29$); moreover significant positive correlation was observed between eNDF and TMR particle size on upper sieve ($r=0.47$). Significant positive correlation was observed among milk production and TMR particles retained on middle sieve ($r=0.56$) and faecal undigested fraction ($r=0.39$). TMR particle size distribution and manure evaluation are useful tools to improve milk production efficiency, indeed the TMR particles retained on middle sieve is positively correlated to milk production and faecal undigested fractions.

Key Words: TMR, Manure Evaluation, Milk Production Efficiency

W110 Intake and milk production of cows fed diets that differed in dietary NDF and NDF digestibility. C. Kendall* and D. K. Combs, University of Wisconsin, Madison.

This study evaluated how intake and milk production were affected by feeding diets that differed in dietary NDF concentration and NDF digestibility. Twelve rumen cannulated, multiparous Holstein cows averaging 39 DIM and producing 39.5 kg/d of milk, were used in a replicated 4 x 4 Latin Square design with 28 d periods. Treatments were arranged in a 2 x 2 factorial with 28% or 32% dietary NDF concentration (DM basis) and two levels of straw NDF digestibility: 1) untreated wheat straw (control, 77 % NDF, 41% NDFD), and 2) anhydrous ammonia-treated straw (76% NDF, 62% NDFD, DM basis). All diets consisted of alfalfa silage, corn silage and a concentrate mix of cracked corn grain, corn gluten meal, 48% soybean meal, vitamins and minerals. Wheat straw comprised 8.5% DM of the 28% NDF diets and 16% DM of the 32% NDF diets. Cows were offered TMR twice daily and fed ad-libitum. Milk and FCM production were higher on the low NDF diets. Milk and FCM also increased when NDF digestibility of the diets was increased. Intake of DM was greater when cows consumed the 28% NDF diets, but intake of total NDF was greater in the 32% NDF diets. Intakes of DM

and total NDF were not affected by NDF digestibility. Milk production and DMI were not affected by the interaction of dietary NDF and NDF digestibility. These results suggest that dietary NDF and NDF digestibility improved milk production additively. Intake was improved by reducing dietary NDF, but DM and total NDF intakes were not affected by NDF digestibility.

Dietary NDF	28	28	32	32	p-value		
Wheat							
Straw	Control	Treated	Control	Treated	SEM	NDF	NDFD
Milk, kg/d	39.3	40.8	36.5	38.6	2.4	.0002	.0038
FCM, kg/d	35.9	37.4	33.0	34.6	2.7	.0001	.0130
DMI, kg/d	22.8	23.4	21.7	22.3	0.8	.0288	.2412
Total NDFI,kg/d	6.3	6.4	6.8	6.9	0.2	.0016	.5425
Dig. NDFI,kg/d	3.0	3.3	3.1	3.7	0.1	.0011	.0001

Total NDFI=Total NDF Intake, Dig.NDFI=Digestible NDF Intake

Key Words: NDF, NDF Digestibility, Milk Production

W111 Effect of physical forms of concentrate on milk composition and milk production of lactating Holstein cows. J. Teixeira*, B. Madeira, L. Teixeira*, and M. Santos, Universidade Federal de Lavras, Lavras, MG, Brazil.

Twenty seven lactating Holstein cows averaging 20 kg of milk yield (50 days lactation) were used in a 3x3 Latin square design trial, with three treatments and three periods of 15 days each. The three treatments tested were the physical forms of concentrate: (T1) pelleted, (T2) meal and (T3) extruded. The diets showed the same chemical composition. This trial was undertaken in Bela Vista Farm, in Curvelo, MG, Brazil. The objective of this trial was to determine the effect of these three different physical forms of concentrate on milk composition and milk production of lactating cows in a free stall. The cows were selected based in milking production and number of lactation. Each experimental period consisted of 9 days of adaptation and six days of milk collection. All cows were fed with napier grass and tifton grass haylage. Were collected and weighed milk samples of two milking per day in every 6-days. The following milk components were determined: fat, total solids, lactose, crude protein and urea using infrared method. The treatments did not affect ($P < 0.05$) milk composition, however the extruded form ($P < 0.05$) decreased urea levels (mg/dl) (T1) 21.88; (T2) 21.15; (T3) 19.16 and increased the milk production and milk production corrected by 4% fat.. Average milk production (kg) were (T1) 17.32; (T2) 17.35; (T3) 18.31 and (T1) 15.66; (T2) 15.78, (T3) 16.81 respectively.

Key Words: Milk Production, Milk Composition, Physical Forms of Concentrate

W112 Daily and diurnal variations in fecal ratios of n-alkanes concentrations in lactating cows grazing a tropical plant. D. E. de Oliveira*², S. R. de Medeiros³, L. J. M. Aroeira⁴, and D. P. D. Lanna⁵, ¹FAPESP, ²Agroceres Nutrio Animal, ³Embrapa Gado de Corte, ⁴Embrapa Gado de Leite, ⁵USP/ESALQ.

The objective of this study was to measure the daily and/or diurnal variation in the fecal concentration of the n-alkanes C₃₁, C₃₂, C₃₃. The ratios of C₃₁:C₃₂ and C₃₃:C₃₂, used in estimation of forage intake were also evaluated. Twenty lactating Holstein x Gir cows were used, ten were individually fed 150g of CLA-60 and the other ten 150g of Megalac, mixed in the morning concentrate (4.0 kg/day). The animals were dosed orally with a controlled-release capsule containing the n-alkanes C₃₂ and C₃₆ and managed in a rotational grazing system os Stargrass (Cynodon nlemfuensis). After seven days of capsule delivery, samples of feces were collected from rectum, every morning and afternoon of the next five days. The forage samples were collected by the

hand plucking method. The n-alkanes were extracted by direct saponification and analyzed by gas chromatography. The variations in the individually fecal concentrations of the n-alkanes and ratios, between the morning and afternoon and among days of collection were done by the Proc Mixed procedure (SAS, 2001). There were treatment effects (CLA=226.9 mg vs. MEG=211.3 mg, $P=0.01$), of time of day (morning=203.3 mg vs. afternoon=235.1 mg, $P=0.0001$) and a linear effect of day of collection (-9.6 mg/day) on the fecal concentration of C_{31} . For the fecal concentration of the n-alkane C_{32} there were effects of time of day (morning=102.5 mg vs. afternoon=109.4 mg, $P=0.0001$) and a quadratic effect of day of collection ($P=0.0001$). The fecal concentration of C_{33} varied between time of day (morning=304.4 mg vs. afternoon=338.7 mg, $P=0.0001$). The $C_{31}:C_{32}$ fecal concentrations ratio varied between time of day (morning=2.16 mg vs. afternoon=2.33, $P=0.0007$). For $C_{33}:C_{32}$ ratio there were differences for time of day (morning=2.96 mg vs. afternoon=3.19 mg, $P=0.0009$) and a quadratic effect for day of collection ($P=0.0001$). The variations observed for fecal ratios of n-alkanes concentrations would have important influence on forage intake estimates.

Key Words: Alkanes, Grazing Cows, Tropical Plant

W113 Changes in milk fatty acids during transition of dairy cows from diets based on conserved forage and grain to pasture. G. Aguiar, T. R. Dhiman*, A. L. Ure, S. F. Porter, and L. L. Jeffs, *Utah State University, Logan.*

Eleven cows were used in a 50 d experiment to study the influence of turning cows out to and withdrawal from pasture on fatty acid (FA) profile and vitamin E levels in milk. Prior to the start of the experiment cows received a total mixed ration (TMR) containing 50% conserved forage and 50% grain. Milk samples were collected from a.m. and p.m. milkings during the first 2 d of the experiment (Phase 1) while cows were fed TMR. On day 3, cows were turned out to the pasture and remained on pasture until day 36 of the experiment (Phase 2). Cows were acclimatized to pasture gradually (25, 50, and 75% pasture for 2 d each) over a period of 1 wk. On day 37 cows were withdrawn from the pasture and remained on the experiment until day 50 (Phase 3) on a TMR diet similar to phase 1. Milk samples from both a.m. and p.m. milkings were collected on alternate days during phases 2 and 3 for FA analysis. Milk samples from day 28 during phase 2 and day 50 of phase 3 were analyzed for vitamin E (α plus γ tocopherol). Cows produced 31.4 ± 3.7 , 17.5 ± 4.6 , and 19.0 ± 6.8 kg milk/d with 3.64 ± 0.02 , 4.02 ± 0.37 , and $3.65 \pm 0.16\%$ fat in phases 1, 2, and 3, respectively. The conjugated linoleic acid (CLA) and $C_{18:1}$ *trans*-11 (TVA) contents of milk were 0.63 and 4.09% of fat during phase 1 and reached a maximum of 2.28 and 7.30% on day 32 of turning cows out to pasture ($P < 0.05$), respectively. The $C_{18:3}$ maximized at day 14 ($P > 0.05$) on pasture. Total ω -3 FA were 0.38% of milk fat during phase 1 and increased to 1.12% of fat by day 16 ($P < 0.05$) on pasture. The vitamin E level of milk was higher ($P < 0.001$) when cows were grazing on pasture during phase 2 as compared to consuming conserved forage and grain during phase 3 (0.44 vs. 0.24 $\mu\text{g}/\text{ml}$). Cows grazing on pasture exhibit higher CLA, ω -3, and vitamin E levels in milk compared with cows consuming a forage plus grain diet. In addition, cows moving from a conventional diet to grazing on pasture with a 1 wk transition period may require a minimum of 4 wk to maximize/stabilize CLA, TVA and ω fatty acid levels in milk.

Key Words: Cow, Pasture, Fatty Acid

W114 Preparation of fresh forage for *in vitro* and *in sacco* incubations. A. V. Chaves¹, G. C. Waghorn*², and I. M. Brookes¹, ¹*Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand*, ²*Dexel Limited, Hamilton, New Zealand.*

In vitro and *in sacco* procedures are well established and are usually carried out on forage prepared by freeze drying and grinding through a 1 mm screen. This may be appropriate for grains and high dry matter material, but is not necessarily suitable for ruminants grazing fresh pasture. Ideally the sample preparation for *in vitro* and *in sacco* incubations of fresh forages to determine digestion characteristics should mimic the particle distribution resulting from chewing during eating and rumination. The objective of this work was to compare the particle size

distribution of the rumen contents of animals fed forages and ryegrass prepared using a mincer. Frozen ryegrass at different stages of maturity were chopped into approximately 2 cm lengths (scissors) and minced in a Kreft Compact meat mincer R70 fitted with a screen plate with 12 mm holes. The mincer components were placed in a freezer prior to mincing to ensure the grass remained frozen and this enabled the forage to be macerated rather than squeezed and prevented excessive cell wall rupture during mincing. The process was designed to mimic effects of chewing by ruminants as far as possible. Samples of minced forage were retained for measurement of particle size distribution by wet sieving. Mincing enabled 37% of DM able pass a 0.25 mm sieve and 31% was unable to pass a 2 mm sieve. This distribution is similar to that of rumen contents in sheep and cattle fed forages but the soluble (A) fraction from ryegrass accounted for a slightly higher proportion of DM than identified by sieving. The higher value for A fraction supports studies showing chewing ruptured 60% of the fresh forage cells. The technique for measuring particle size and release of cell contents may contribute to these anomalies. The mincing preparation used for *in vitro* and *in sacco* incubations showed a high degree of uniformity and the proportional distribution of DM across particle sizes resemble these for chewed forage and rumen contents. The preparations used here provide sufficient large particles which are important in forage incubations and mimic mastication by ruminants.

Key Words: Preparation, Forage, Incubations

W115 Inducing subacute ruminal acidosis (SARA): Effects on ruminal pH, DMI, and milk production. K. M. Krause* and G. R. Oetzel, *School of Veterinary Medicine, University of Wisconsin, Madison.*

Data from trials in which SARA was induced in lactating dairy cows (DIM 154 ± 118) were evaluated in order to investigate the effectiveness of the induction protocol and its effect on production parameters. For 13 cows in three trials, ruminal pH was measured continuously and recorded each minute; dry matter intake and milk yield was recorded daily. Milk composition data were obtained from 9 cows in two of these trials. The SARA induction protocol included four separate Periods: four days of Baseline (normal TMR fed), one day of 50% Restricted feeding, one or two day of Challenge feeding (addition of 4-5 kg wheat/barley pellet to normal TMR), and two days of Recovery measurements when feeding normal TMR. Data were analyzed including Period, Trial, and their interaction in the model. Mean comparisons were by least significant difference method after a significant ($P < 0.05$) Period effect was found. All reported differences are significant ($P < 0.05$). The SARA induction protocol lowered mean ruminal pH from 6.29 during the Baseline period to 5.86 during the Challenge period; pH remained below Baseline level during the Recovery period (6.15). Mean ruminal pH was highest (6.57) during the day of Restricted feeding. Nadir ruminal pH decreased from Baseline to Challenge period (5.73 vs. 5.17). Hours below pH 5.6 increased from 1.4 to 8.3 per d from Baseline to Challenge period and area below 5.6 (pH x min/d) increased from 18 to 198. Dry matter intake was not affected by SARA induction. Milk yield dropped from 35.2 kg/d during Baseline to 31.7 kg/d during the Challenge period and did not return to Baseline level during the Recovery period (31.3 kg/d). No depression in milk fat percentage was observed when SARA was induced. Yield of fat was highest during the Restricted feeding period (1.47 kg/d) and was lower during the Recovery period than during the Baseline period (1.12 vs. 1.31 kg/d). Protein percentage was unaffected by the protocol. The protocol successfully induced SARA (low ruminal pH) on the Challenge day. Milk yield was substantially reduced and did not recover within two days after the challenge.

Key Words: Subacute Ruminal Acidosis, Dry Matter Intake, Milk Production

W116 The effects of monensin on feed intake pattern during sub-acute ruminal acidosis in dairy cows. D. E. Lunn¹, T. Mutsvangwa¹, N. E. Odongo*¹, T. F. Duffield², R. Bagg³, P. Dick³, G. Vessie³, and B. W. McBride¹, ¹*Department of Animal and Poultry Science, University of Guelph, Ontario, Canada*, ²*Department of Population Medicine, University of Guelph, Ontario, Canada*, ³*Elanco Animal Health Division, Eli Lilly Canada Inc, Guelph, Ontario, Canada.*

The objective of this study was to determine the effects of monensin on feed intake patterns during induced sub-acute ruminal acidosis (SARA)

in Holstein dairy cows fed a total mixed ration (TMR). The experiments were conducted as a two-treatment, two-period crossover design with a 7-d adaptation period before induction of SARA, a 10-d SARA period and a 7-d post SARA recovery period using six multiparous Holstein cows (630.5 ± 35.4 kg BW; 81.2 ± 49.6 DIM; experiment 1 and 667.7 ± 46.2 kg BW; 150.2 ± 53.2 DIM; experiment 2). In experiment 1, monensin was administered as a controlled-release capsule (Rumensin[®] CRC) (32 g of monensin sodium blended into a hexaglycerol distearate matrix core) whereas in experiment 2, monensin was added as Rumensin[®] Premix (22 ppm of dry matter) using soybean hulls as carrier. In both experiments, the control diet was identical to the monensin treatment diet except it did not contain monensin. Feed intake patterns were monitored continuously over 24 hrs using a weigh cell system within the manger and meal size and meal duration recorded by a computer hooked to the system. SARA was induced by restricting TMR intake to 85% of ad libitum intake and replacing the remaining 15% with a grain pellet consisting of 50% wheat and 50% barley. In both experiments, the number of meals consumed during SARA were lower (P<0.05) than during the adaptation and recovery periods suggesting the animals might have been attempting to attenuate SARA by reducing intake. In experiment 1, CRC had no effect (8.7 vs. 8.7, P=0.96) on feed intake patterns although there was a tendency (7.4 vs. 8.0, P=0.19) for number of meals consumed on CRC during SARA to be higher. In experiment 2, the premix significantly increased the overall number of meals consumed (7.3 vs. 8.1, P=0.01); number of meals consumed during SARA (6.0 vs. 7.2, P=0.04) and number of meals consumed during the recovery period (7.5 vs. 9.0, P=0.004). These results suggest monensin may increase meal frequency in lactating dairy cows when under conditions of SARA. However, potential differences in the mode of action between monensin delivered in a Rumensin[®] CRC or in Rumensin[®] Premix merits further research.

Key Words: Dairy Cows, Ruminant Acidosis, Monensin

W117 Diet digestibility and rate of passage in Jersey and Holstein Friesian cows during transition. P. C. Aikman^{*1}, A. Boydell², A. Le Gallais³, D. J. Humphries¹, C. K. Reynolds⁴, and D. E. Beever¹, ¹CEDAR, The University of Reading, UK, ²BOCM PAULS Ltd, Bristol, UK, ³Jersey Milk Marketing Board, St. Saviour, NJ, ⁴The Ohio State University, Wooster.

The effect of breed on diet digestibility and rate of passage (ROP) was measured in six Jersey (J; initial BW 462 ± 18 kg) and six Holstein Friesian (HF; initial BW 678 ± 18 kg) third parity cows at wk 5 before expected calving date (ECD) and wk 6 and 14 postpartum. From drying-off until wk 3 before ECD cows were fed a TMR (660 g grass silage, 220 g grass hay and 120 g concentrates/kg DM; 146 g CP and 523 g NDF/kg DM) according to BW. From calving, cows were fed ad libitum a TMR (311 g corn silage, 311 g grass silage and 378 g concentrates/kg DM; 173 g CP and 386 g NDF/kg DM). Digestibility was assessed by total faeces collection for 5 d. To determine ROP a dose of Cr-mordanted grass silage (1% of DMI) was fed at the start of each period and Cr concentration in faeces measured at regular intervals for 120 h post-dosing. Transit time (TT; h to first appearance of Cr in faeces) and rate constants describing the proportion of feed passing out of the rumen (k₁) and hindgut (k₂) per hour were estimated. HF had higher (P < 0.001) DM, OM, starch, NDF and ADF intakes (18.12, 16.88, 2.91, 6.92 and 4.18 kg/d, respectively) than J (12.26, 11.41, 1.86, 4.82 and 2.94 kg/d, respectively). Breed did not affect digestibility of DM, OM, starch or ADF (respective mean values: 712, 733, 941 and 538 g/kg). NDF digestibility was higher (P < 0.008) in J compared to HF (629 and 602 g/kg respectively). k₁ was higher (P < 0.016) in J than HF (0.031 v 0.027), k₂ tended to be higher in J than HF (0.078 v 0.074, P < 0.106), but TT did not differ (12.19 v 11.46 h, J and HF respectively, P > 0.377). Fiber digestibility and TT declined (P < 0.001) in both breeds as DMI increased postpartum, but the decrease in TT was less in J (P < 0.050). In conclusion, k₁ was greater for J than HF at equal DMI/kg BW. NDF digestibility was higher for J cows despite faster ROP from the rumen, which may reflect differences in mastication and particle size reduction.

Key Words: Jersey Cows, Digestibility, Rate of Passage

W118 The effects of glucogenic supplements prepartum and calcium soap of fatty acids postpartum on production and peripartum metabolites in high producing dairy cows. U. Moallem^{*1}, H. Lehrer¹, M. Katz^{1,2}, and D. Sklan², ¹Department of Dairy Cattle, Institute of Animal Science, ARO, Isreal, ²Animal Science Department, Faculty of Agriculture, Hebrew University, Rehovot, Isreal.

This study examined the effects of feeding supplements containing glucogenic precursors prepartum and calcium salts of fatty acids (CSFA) postpartum until 120 DIM, on production and blood metabolites. Twenty-four dry and 250 d pregnant cows were housed in an open barn with electronic individual feeding system and were divided on the basis of previous milk production and parity to one of two treatments: control: dry cow diet (NRC requirements) 2) treatment fed the control diet + top dressed with 550 g of a commercial glucogenic supplement (ProGlyc 55; PG). After calving each prepartum group was subdivided to groups that were fed either the control lactating diet or the control diet supplemented with 550 g CSFA. After calving cows were milked and weighed three times a day, BCS was determined weekly and blood samples were taken 3 times a week until 70 DIM. Insulin, glucose, beta-hydroxybutyrate (BHB), triglycerides (TG), cholesterol and aspartate amino transferase (AST) were determined in blood until 30 DIM. The PG supplementation decreased DMI by 6% pre and postpartum and postpartum CSFA decreased DMI by 2.3%. Milk production was decreased by 6.4%, fat percentage was not changed and protein was enhanced by 4% in cows fed PG prepartum. BCS was increased earlier after calving in cows fed PG prepartum. Feeding PG prepartum enhanced insulin, glucose and cholesterol plasma concentrations throughout (P<0.004) and decreased BHB and AST pre and postpartum. Postpartum CSFA decreased glucose and increased cholesterol plasma concentrations with no change in BHB, AST and TG. Significant interactions were observed between prepartum PG and postpartum CSFA in reducing BHB (P<0.007). In conclusion, supplementation of glucogenic precursors pre-calving improved body condition and the metabolic status of dairy cows, pre and post partum.

Key Words: Transition Cow, Glucogenic Precursors, Calcium Soap of Fatty Acids

W119 Physiological responses of Holstein cows fed rations with glucogenic supplements during the transition period. T. I. Belloso^{*1}, M. J. Hayen¹, M. Liboni¹, M. S. Gulay¹, F. Valdez², and H. H. Head¹, ¹University of Florida, Gainesville, ²Kemin Americas, Lancaster, OH.

Multiparous Holstein cows (n=124) were used to evaluate effects of supplementing glucogenic compounds in daily TMR fed during the transition period (-3 wk to +4 wk). Treatments (TRT) were 1) control (CON), none, n=29; 2) NutroCal (NUT; Kemin AmericasTM), 0.114 kg/d, n=33; 3) Metaxerol (MET; Pestell AmericaTM), 0.454 kg/d, n=31; and 4) propylene glycol (PPG), 0.300 kg/d, n=31. Supplements were added to ~13kg of close-up TMR (-3 wk to calving) or lactating TMR (calving to +4 wk) fed in a.m. Blood samples were taken 3x a week and analyzed for concentrations of insulin, IGF-I, glucose, NEFA, β-HBA, and calcium in plasma. Total liver fat (wet weight basis) ~21 d, around calving, and +14 and +28 d postpartum was determined on biopsies taken from a subset of 10 cows/TRT. Overall, blood measures followed expected patterns for Holstein cows during this time period. No incidences of fatty liver or treatment effects on percentage liver fat were detected. However, liver of NUT supplemented cows had numerically greater fat percentage (~30%) compared to CON and PPG supplemented cows, and ~58% more than MET supplemented cows. There was a biopsy day effect (P=0.002) on total liver fat; greatest percentages in liver were on d +14 (9.9%). Adding glucogenic compounds to TMRs fed to transition cows did not alter expected changes in plasma insulin, IGF-I, metabolites or liver lipids around calving but differences in changes were detected due to supplement included in TMR during this period.

Blood Measure		Treatment			PPG
		CON	NUT	MET	
IGF-I (ng/mL)	Prepartum	259.1 ^b	256.3 ^b	229.8 ^a	255.3 ^b
	Postpartum	139.9 ^a	144.6 ^a	142.7 ^a	165.1 ^b
NEFA (μ eq/L)	Prepartum	154.5 ^{ab}	149.6 ^a	192.3 ^c	185.0 ^{bc}
	Postpartum	515.7 ^b	529.4 ^b	477.6 ^{ab}	430.3 ^a
β -HBA (mg/dL)	Prepartum	4.09	4.20	4.18	4.16
	Postpartum	8.24 ^b	8.64 ^b	7.12 ^{ab}	6.24 ^a
Glucose (mg/dL)	Prepartum	71.4	70.9	70.3	70.5
	Postpartum	61.8	61.5	63.3	65.0
Insulin (ng/mL)	Prepartum	0.72 ^{ab}	0.77 ^b	0.67 ^a	0.76 ^{ab}
	Postpartum	0.41	0.41	0.41	0.45
Calcium (mg/dL)	Prepartum	8.39 ^a	8.68 ^{ab}	8.74 ^b	8.45 ^{ab}
	Postpartum	8.58	8.71	8.73	8.53

^{abc} Means with different letters within rows differed ($P < 0.10$)

Key Words: Glucogenic Compounds, Blood Measures, Liver Fat

W120 Ruminal and plasma responses in dairy cows to drenching or feeding glycerol. P. L. Linke^{*1}, J. M. DeFrain¹, A. R. Hippen¹, and P. W. Jardon², ¹South Dakota State University, Brookings, ²West Central Soy, Ralston, IA.

Four Holstein dairy cows (137 DIM, 60 kg milk/d) were used in a Latin square design with 1-wk periods to evaluate the effect of methods of oral delivery of glycerol on ruminal VFA and plasma glucose and insulin. All cows were fed only grass hay for ad libitum consumption during 12 h before the experiment. At the start of the experiment, all cows were fed 5 kg of cracked corn. Treatments were: 1) control (C), no glycerol; 2) fed glycerol (F), 1 kg of glycerol solution (80% glycerol) added to the corn; 3) drench glycerol (D), 1 kg of glycerol solution in 1 L of water and delivered as oral drench; and 4) tube delivery of glycerol (T), 1 kg of glycerol solution in 9 L of water and delivered via an esophageal tube. Blood samples were collected at -1, -0.5, 0, 0.25, 0.5, 0.75, 1, 1.5, 2, 4, 6, 8, 12, and 24 h after administering glycerol. Ruminal samples were collected at 0, 2, 4, and 6 h. Acetate decreased ($P < 0.05$) in rumens of cows given glycerol, reaching nadir at 4 h (53.3, 44.9, 44.6, and 43.0 mol% for C, F, D, and T). Propionate and butyrate were increased ($P < 0.05$) by glycerol with peak concentrations at 4 h (26.4, 28.7, 30.4, and 30.4 and 14.1, 20.0, 20.3, and 21.5 mol%, respectively). Glucose was increased ($P < 0.05$) in plasma of D and T compared with C, reaching peak concentrations (21.3 and 18.5 mg/dl over baseline) at 1.5 and 3 h for D and T, respectively. Glucose response expressed as area under the curve (AUC) over baseline for 8 h was greater ($P < 0.05$) for D and T compared with C (9.4, 23.6, 54.6, and 58.1 mg/dl for C, F, D, and T). Insulin concentrations in plasma were increased ($P < 0.05$) for D and T reaching peak concentrations (97 and 115 pg/ml over baseline) at 1.4 and 1.1 h for D and T respectively. The 8-h AUC for insulin concentrations were greater ($P < 0.05$) for D and T than for F and C (80, 67, 244, and 270 pg/ml for C, F, D, and T). These data demonstrate that the ability of glycerol to increase plasma concentrations of glucose and insulin is dependent upon rapid delivery.

Key Words: Glycerol, Metabolites, Volatile Fatty Acids

W121 Adipose tissue metabolism, feed intake and milk production in response to dietary calcium propionate and chromium propionate from 21 days prepartum to 35 days postpartum in Holstein dairy cattle. J. P. McNamara^{*1} and F. Valdez², ¹Washington State University, Pullman, ²Kemin Industries, Inc, Des Moines, IA.

The objective was to determine the action of calcium propionate and chromium propionate on rates of lipogenesis and lipolysis in adipose tissue, dry matter intake and milk production when fed to Holstein dairy cattle 21 days prepartum to 35 days postpartum. Twelve animals each were assigned to treatments: Control, CaP (.125 kg/d); CrP (10 mg trivalent Cr/d) and both CaP and CrP. Dry matter intake and milk production was determined daily from 21 to 90 d. Biopsies of adipose tissue were taken at 7, 14, 28 and 56 d from calving. In control cows, rates of lipogenesis dropped to 98 % of 7 d rates and stayed there through d 56. Lipogenesis in cows treated with either CaP or CrP was 25 to 140 % faster (1.25 to 14 times as fast) at 14 and 28 d postpartum and had returned to prepartum rates by 56 d. Rates of lipolysis in vitro doubled

from 7 to 28 d but were not different at 14 and 56 d from 7 d. On CaP, lipolysis was 94, 79, 53 and 243 % of control and on CrP: 84, 97, 81 and 150 % of control at d 7, 14, 28 and 56. Dry matter intake averaged 11.2 (SD 1.85) and 21.8 (SD 3.7) kg/d from 21 to 1 and 1 to 90 days about calving. CaP increased DMI 11 and 13 % pre and postpartum; CrP increased DMI 10 and 16 % ($P < 0.05$); the combination had no effect. Milk yield was 44.6 (SD 8.7) kg/d overall and CrP increased milk yield by 2 kg/d or 4 % during the first 90 DIM. Milk fat yield was 92 to 95 % of control on CaP and CrP, the difference is approximately the same as the reduction in lipolysis. Milk lactose, protein and solids not fat were not different among treatments. The data are consistent with the theory that providing a small amount of gluconeogenic precursors can reduce net lipolysis from adipose tissue and allow increased feed intake, from which some of the nutrients are partitioned to milk. Additional dietary Cr may be acting through the glucose transporters to increase glucose flux into adipocytes and stimulate more lipogenesis and reduce lipolysis.

Key Words: Adipose, Gluconeogenesis, Lipolysis

W122 Effect of rumen protected choline on liver metabolism in periparturient dairy cows. P. Elek^{*1}, F. Husv eth², T. Ga al³, and J. R. Newbold⁴, ¹AGROKOMPLEX C. S. Co., Zichyujfalva, Hungary, ²Veszpr em University, Keszthely, Hungary, ³Szent Istv an University, Budapest, Hungary, ⁴Provimi Research and Technology Centre, Brussels, Belgium.

The aim of this experiment was to study the effect of rumen protected choline (RPC) on metabolism during the periparturient period. Thirty high producing multiparous Holstein cows were paired by parity, body condition score and previous lactation performance and randomly assigned to one of two groups. Cows were fed 0 (control) or 100 g/d RPC (RPC group, equivalent to 25 g/d choline chloride) from an average of 21 d prepartum and 0 or 200 g/d RPC (equivalent to 50 g/d choline chloride) from calving to 60 d postpartum. RPC was a fat encapsulated product therefore hydrogenated palm oil was used to equalize fat intake in the control diet. All cows were offered a TMR of identical ingredient composition (corn silage 300 g/kg DM, alfalfa hay 160 g/kg DM, wet brewers grain 50 g/kg DM, corn, soybean meal based concentrate 490 g/kg DM). Body condition (BCS) was scored and liver biopsies were taken at -21, 7, 35 and 60 d relative to calving and milk samples were collected on d 7, 35 and 60 postpartum for measurement of choline concentration. BCS and BCS change did not differ between treatments. Total lipid content of the liver varied considerably between cows but was significantly ($P < 0.05$) lower in RPC group (control vs. RPC, g/kg wet weight: 145.8 vs 81.7 (day 7 after parturition), 84.9 vs. 49.6 (day 35)). Glycogen concentration differed significantly only on 35 d sampling; it was higher in the RPC group (control 27.9 vs. RPC 35.8 g/kg wet weight). Milk total choline concentration was significantly ($P < 0.01$) higher in RPC group (control vs. RPC, mg/kg milk: 86.2, 109.4; 97.1, 143.0; 115.3, 137.2; for days 7, 35 and 60, respectively), which proves the better choline supply of RPC supplemented cows. Feeding RPC during the periparturient period had a positive effect on liver metabolism as evidenced by lower total lipid and higher glycogen content.

Key Words: Choline, Cow, Liver

W123 Supplemental choline for prevention and alleviation of fatty liver. R. R. Cooke, R. R. Grummer^{*}, S. J. Bertics, D. Z. Caraviello, M. H. Ramos, and N. Silva del Rio, University of Wisconsin-Madison.

Experiments were conducted to determine if supplemental choline could prevent or alleviate fatty liver in dairy cattle. In experiment 1, 24 cows between 45 and 60 d prepartum were blocked according to body condition and randomly assigned to control or 15 g choline/d in a ruminally protected form (RPC; Reashure, Balchem Encapsulates). From d 0 to 6, all cows were fed 1.4 kg of concentrate/d (without RPC), forage was consumed ad libitum, and samples were obtained for covariate analysis. During fatty liver induction (d 7-17), cows were fed 1.4 kg concentrate/d with or without RPC and forage intake was restricted so that cows consumed 30% of maintenance energy requirements. During fatty liver induction, RPC did not affect blood glucose ($P = 0.42$), but did decrease plasma nonesterified fatty acid (NEFA, 703 vs 562 μ Eq/L, SE = 40, $P = 0.003$) and liver triglyceride (TG) (16.7 vs 9.3 μ g/ μ g DNA, SE = 2.0, $P = 0.015$). Experiment 2 was conducted to determine if RPC could alter the rate of TG depletion from liver when cows are fed in excess

of energy requirements following induction of fatty liver. Twenty-eight cows between 45 and 60 d prepartum were blocked according to body condition and assigned to treatment. Fatty liver was induced by feeding 1.4 kg concentrate/d (without RPC) and restricting forage intake so cows consumed 30% of maintenance energy requirements for 10 d. For the next 6 d, cows were fed 1.4 kg concentrate/d with or without RPC and forage was consumed ad libitum. Treatments were not applied during fatty liver induction, however, liver for cows assigned to control and RPC contained 6.8 and 12.7 ug TG/ug DNA following feed restriction. Measurements obtained prior to treatment served as covariates for statistical analysis. During the depletion phase, plasma glucose and NEFA were not affected by treatment. Liver TG, expressed as a percentage of that after induction and prior to treatment, was 60.4 and 52.2 (SE = 6.0) on d 3 and 48.5 and 29.9 (SE = 6.5) on d 6 of the depletion phase for control and RPC (P = 0.12 for treatment, P = 0.07 for treatment x time). RPC can prevent and possibly alleviate fatty liver induced by feed restriction.

Key Words: Choline, Fatty Liver

W124 Feeding soybeans and rumen-protected choline to dairy cows during the periparturient period and early lactation. 1. Effects on production and energy balance. W. A. Oelrichs*, M. C. Lucy, M. S. Kerley, and J. N. Spain, *University of Missouri - Columbia*.

This study was designed to investigate the effects of soybeans (SB) and rumen-protected choline (RPC; Reashure™ Choline; Balchem, Slate Hill, NY) fed during the periparturient period and early lactation on intake and production of dairy cows. Sixty-four Holsteins were blocked by parity and expected calving date and randomly assigned within block to one of six experimental diets. Dietary treatments were fed from 28 days prepartum to 100 days in milk. Cows were assigned to treatments in a 3 x 2 factorial arrangement. Cows received no SB, SB beginning at calving, or SB for the duration of the study. SB were fed as 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 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. Body weights and body condition scores were measured weekly throughout the study. Cows were milked 2x daily, and milk yields were recorded. Blood samples were collected weekly prepartum, at days -3, 0, and +3 relative to calving, and twice weekly postpartum. Plasma were analyzed for NEFA, glucose and γ -hydroxybutyrate. Cows fed RPC consumed significantly more DM as a percent of BW over the entire study period. Feeding RPC increased milk yield with little or no change in BW or BCS. Plasma NEFA and γ -HBA concentrations were lower in cows fed RPC. Cows may use energy for milk production more efficiently when fed RPC. Cows fed SB during the prepartum period had lower postpartum DMI than cows fed the other diets. Feeding SB beginning at 28 days prepartum resulted in reduced milk production throughout the study. Cows fed SB beginning either 28 days prepartum or at calving had more positive energy balance, reflected in lower plasma NEFA and higher plasma glucose concentrations. Although SB can be used as an alternative energy source, these results suggest that feeding should not be initiated until after calving.

Key Words: Transition Cows, Rumen-Protected Choline, Soybeans

W125 Feeding soybeans and rumen-protected choline to dairy cows during the periparturient period and early lactation. 2. Effects on reproduction. W. A. Oelrichs*, M. C. Lucy, M. S. Kerley, and J. N. Spain, *University of Missouri - Columbia*.

This study was designed to investigate the effects of soybeans (SB) and rumen-protected choline (RPC; Reashure™ Choline; Balchem, Slate Hill, NY) fed during the periparturient period and early lactation on reproductive performance of dairy cows. Sixty-four Holsteins were blocked by parity and expected calving date and randomly assigned within block to one of six experimental diets. Dietary treatments were fed from 28 days prepartum to 100 days in milk. Cows were assigned to treatments in a 3 x 2 factorial arrangement. Cows received no SB, SB beginning at calving, or SB for the duration of the study. SB were fed as raw, cracked beans at feeding rates of 1.9 and 2.8 kg DM per cow per day during pre- and postpartum periods, respectively. TRPC was top-dressed 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. Blood samples were collected once weekly prepartum, at days 3, 0, and +3 relative to calving, and twice weekly postpartum. Plasma were analyzed for NEFA, glucose, γ -hydroxybutyrate, and progesterone. Cows were estrous synchronized for oxytocin challenge and timed AI. Plasma obtained during oxytocin challenge were analyzed for 13, 14-dihydro 15-keto prostaglandin F₂ α (PGFM). Feeding RPC increased plasma progesterone concentrations during first synchronized estrous cycle, and improved conception and pregnancy rates. Feeding SB beginning either prepartum or on the day of calving had little influence on reproduction. Plasma progesterone concentrations, interval to first estrous cycle, plasma PGFM concentrations during oxytocin challenge, and rates of cyclicity, ovulation, conception and pregnancy were not different due to feeding SB. However, during the first synchronized estrous cycle, cows fed SB beginning at 28 days prepartum or on the day of calving had fewer small (< 5 mm) follicles and tended to have more medium follicles (6 to 9 mm) than cows fed the control diets. Other studies have reported a more dramatic improvement in reproductive performance.

Key Words: Transition Cows, Soybeans, Rumen-Protected Choline

W126 Estimation of VFA and Glucose Kinetics on Transition Dairy Cows provided monensin. X. Markantonatos*¹, Y. Aharoni³, T. Cassidy¹, R. K. McGuffey², L. F. Richardson², and G. A. Varga¹, ¹*The Pennsylvania State University*, ²*ELANCO Animal Health, Greenfield, IN*, ³*ARO, Newe Yaar Research Center, Israel*.

Eight multiparous Holstein dairy cows were used to evaluate the effects of monensin (M) inclusion during the transition period on ruminal VFA and plasma glucose kinetics. Treatments were a TMR top-dressed with 300 mg M/d, or without M. Cows received M from d -30 prepartum (Pre) to d +56 postpartum (Post). 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 bolused and intraruminally infused. Tracers were infused on d 13 ± d 1.97 prior to calving and on d 19 ± 1.60 after parturition. Three days prior to sampling, cows were fed every 4 h for 2 d followed by 2 h feeding intervals 1 d prior to and the day of sampling. 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. A dose of 45 mg of U-¹³C-Glucose (Glu) was injected into the jugular vein. Blood was sampled 20 times during 8 h after tracer administration. WinSAAM simulation program, which assumed a 12-compartment model, was used to analyze Glu and VFA ¹³C Enrichment Curves with Time (ECT). Acetate (Ac) conversion to Butyrate (Bu) was higher Post (2.36mmol/min vs 1.33mmol/min; Post vs Pre). Similarly, Pr incorporation to Glu pool was 0.86mmol/min vs 0.24mmol/min (Post vs Pre) and did not differ between treatments. Propionate (Pr) production rate was numerically higher in M cows (P=0.24) Pre, whereas Glu clearance rate was lower in M cows (4.88mmol/min vs 8.78mmol/min; P<.0001). Glu input rates from other sources than Pr was lower in M vs C (1.79mmol/min vs 3.04mmol/min; Pre, 6.90mmol/min vs 13.37mmol/min; Post). ECT shown that each individual VFA acts kinetically as a single pool. This study suggests that inclusion of M may affect VFA and Glu kinetics, and may also spare glucose to reduce metabolic diseases such as ketosis as the cow transitions into lactation.

Key Words: Monensin, VFA, Glucose Kinetics

W127 Effect of level of prepartum alimentation in dairy cows on milk production, mRNA expression for gluconeogenic enzymes, and liver triglyceride concentration. J. R. Townsend* and S. S. Donkin, *Department of Animal Sciences, Purdue University, West Lafayette, IN*.

Dry matter intake depression in prepartum dairy cows has been implicated in impaired performance and health. To determine the impact of prepartum DMI on performance and metabolic parameters thirty multiparous Holstein cows were blocked by calving date and randomly assigned to the following treatments: fitted with rumen cannulae and force fed orts during the final 14 days of gestation (force fed, FF), intake restricted during the final 14 days of gestation to 75% of ad libitum DMI (restricted, R), or fed for ad libitum intake during the final 14 days of gestation (control, C). From 28 through 15 days prior to expected calving cows were given ad libitum access feed (1.61 Mcal NEL/kg) and similarly following parturition (1.67 Mcal NEL/kg). Liver biopsy and

blood samples were obtained on days -28, -14, -7, +1, +7, +14, +28, and +56 relative to calving. DMI from day -14 to day +1 differed ($P < .05$) among treatments and was 13.0, 9.8, 11.4 kg/d for C, R, and FF respectively. Postpartum DMI during the first 28 days of lactation was greater ($P < 0.5$) for C (18.3 ± 0.6 kg/d) compared with either R or FF, (15.0 ± 0.7 , 15.6 ± 0.7 kg/d, respectively). Control cows produced more milk ($P < .05$) from 1 through 28 DIM than either R or FF (39.0, 32.4, 34.3 kg/d for C, R, and FF). Milk production from 29 through 56 DIM tended ($P < .10$) to be higher for control cows (47.6, 41.3, 42.7 kg/d for C, R, and FF). Plasma NEFA, PUN, and BHBA levels followed typical periparturient patterns but did not differ among treatments nor did liver triglyceride (TG), glycogen and TG:glycogen ratio. Liver mRNA for pyruvate carboxylase (PC) peaked at calving and phosphoenolpyruvate carboxykinase (PEPCK) peaked postcalving. PEPCK mRNA was not affected by treatment but PC mRNA was elevated ($P < .05$) for FF compared with C. The data suggest that a depression in feed intake as part of the natural transition to lactation is not detrimental to postpartum performance but that imposed feed restriction reduces performance.

Key Words: Transition Cow, Feed Intake, Liver

W128 Nicotinic acid supplemented at a therapeutic level minimizes prepartum feed intake depression in dairy cows. P. D. French*, *Oregon State University, Corvallis.*

Nicotinic acid has been used successfully to treat hyperlipidemia in humans for several decades. However, nicotinic acid (NA) supplementation has not been effective in decreasing plasma non-esterified fatty acids (NEFA) around the time of parturition in dairy cattle. The objective of the following experiment was to determine the effect of therapeutic NA supplementation on prepartum feed intake and plasma NEFA. Beginning 30 d prior to calving date, 14 multiparous Jersey cows were blocked by expected calving date and assigned at random to one of two treatments: no supplemental NA (control; C) or 48 g NA/d. The level of NA supplementation was based on human dosages adjusted for weight and predicted rumen stability. Cows were group housed and fed individually via Calan(r) doors beginning 30 d prior to calving date. Cows were offered a TMR once daily and NA was topdressed to ensure a daily consumption of 48 g. The TMR contained 34% (DM basis) corn silage, 14% alfalfa hay, 14% oat hay, 19% corn/barley, 9% soybean meal/corn distillers, 3% molasses, and 7% mineral/vitamin premix. Nicotinic acid supplementation and data collection began 24 d prior to expected calving date. Data were analyzed as repeated measures using the MIXED procedure of SAS. Body weight and body condition score were similar for C and NA. Dry matter intake differed for treatment by day ($P < 0.01$) and was greater the day prior to parturition for cows receiving NA compared to C, 10.0 and 6.7 kg, respectively. Dry matter intake decline, calculated as the change in DMI versus 14 to 21 d average, the last week of gestation was greater ($P < 0.05$) for C (20.5%) compared to NA (4.7%). Plasma non-esterified fatty acids were greater ($P < 0.01$) the day of parturition (1244 and 491 $\mu\text{mol/l}$ for C and NA, respectively) and the day after parturition (716 and 328 $\mu\text{mol/l}$ for C and NA, respectively) for C compared to NA. Results show that NA reduces plasma NEFA by 65% at parturition, and a cause and effect relationship between plasma NEFA and feed intake depression has been established.

Key Words: Feed Intake, Nicotinic Acid, Prepartum

W129 The effects of supplemental anionic salt fed during the periparturient period: Implications of milk production and feed intake for high producing dairy cows. J. Spain, R. J. Vogel*, and J. D. Sampson, *University of Missouri - Columbia.*

The objective of this study was to determine the effect of a sulfur-based anionic salt fed during late gestation on intake, health, and production of Holsteins. Twenty-six mature cows were paired by expected calving date, lactation number, milk production potential, and body weight. Cows within pair were then randomly assigned to one of two diets. The dietary treatments were control (C) and supplemental anionic salt (A). Cows were fed the experimental diets as TMR via electronic feeding gates. Control diet was formulated to achieve a Dietary Cation-Anion Difference (DCAD) of +20 mEq/100 g dry matter. Control diet was predicted to provide 70g of calcium per cow per day. The treatment

group was fed 454g per cow per day of a commercially formulated anionic salt supplement which lowered the DCAD level to -10 mEq/100 g dry matter. Treatment diets were formulated to provide a daily intake of 150g of calcium per cow per day. Diets were fed 30 days prior to expected day of calving. At calving, cows were fed standard lactation TMR for the first 6 weeks of lactation. Feed intake was measured daily. Urine pH was monitored twice each week using an electronic pH meter. Blood samples were collected weekly prepartum as well as on day -3 and day of calving. Postpartum blood samples were collected on day 1, 3, 7, 10 and 14 of lactation and then weekly until day 42. Blood samples were analyzed for Ca and NEFA. Daily milk yields and weekly milk component data were also collected. These data were analyzed for significance using SAS Proc Mixed. Cows fed anionic salts had lower urine pH compared to control cows (6.78 vs. 8.29; $P < 0.0001$). Blood calcium was higher for anionic salt fed cows compared to control cows (8.87 vs. 8.63 g/dl; $P = 0.05$). Plasma NEFA were lower for cows fed anionic salt diet (292 vs. 402 $\mu\text{eq/l}$; $P < 0.01$). Milk was greater over time for cows fed anionic salts versus control cows ($P = 0.05$). Supplementation with sulfur based anionic salt improved calcium and energy balance associated with significant increase in milk production.

Key Words: Anionic Salt, DCAD, Transition Cows

W130 Effects of dry period length on performance and health of dairy cows during the subsequent lactation. J. Fernandez*, C. M. Ryan, D. M. Galton, and T. R. Overton, *Cornell University, Ithaca, NY.*

Holstein cows ($n = 67$) on two commercial dairy farms and producing at least 27 kg/d of milk at approximately 60-d prior to expected parturition were used to determine whether dry period length affects milk yield, milk composition, and metabolic indices during the subsequent lactation. At 60-d prior to expected parturition, cows were assigned randomly to receive either 60-d dry (actual 57 ± 5 d), 40-d dry (actual 41 ± 7 d), or 0-d dry. Milk yield and composition data were collected for the first six monthly test days of the subsequent lactation. Interactions of farm by treatment were not significant ($P > 0.05$) for all variables measured. Cows managed for 60 and 40-d dry periods had comparable yields of milk, fat, 3.5% fat-corrected milk (FCM), and true protein during the first 6 months of the subsequent lactation. Cows managed for 0-d dry periods produced approximately 10 kg/d less milk than cows managed for 40 or 60-d dry periods during the first 6 months of the subsequent lactation. Yields of milk fat, true protein, and 3.5% fat-corrected milk by cows managed for 0-d dry periods were decreased compared to those managed for 40 or 60-d dry periods. Concentrations of B-hydroxybutyrate (BHBA) in single plasma samples collected on d 5 to 20 postpartum were not affected ($P > 0.15$) by treatment. Overall, performance and health during the subsequent lactation of cows managed for 60 or 40-d dry periods were comparable in this experiment; cows managed for 0-d dry had substantially decreased milk yield during the subsequent lactation.

Item	60-d dry	40-d dry	0-d dry	SEM
Milk, kg/d	47.1 ^a	46.3 ^a	37.1 ^B	1.8
Fat, %	3.52	3.58	3.32	0.14
Fat, kg/d	1.67 ^a	1.61 ^a	1.24 ^b	0.09
3.5% FCM, kg/d	48.0 ^a	46.2 ^a	36.7 ^b	2.0
Protein, %	2.73 ^a	2.84 ^b	2.83 ^b	0.06
Protein, kg/d	1.30 ^a	1.30 ^a	1.06 ^b	0.04
BHBA, mg/dl	11.1	10.3	9.4	0.7

^{ab} Means within row with different superscripts differ, $P < 0.05$.

Key Words: Dairy Cow, Dry Period

W131 Effects of Tri-Lution™ on immune response in the pre-fresh dairy cow. D. Jones*, D. Spangler, and R. Arendt, *Agri-King, Inc, Fulton, IL.*

Fifty-six cows were utilized in a completely randomized design to evaluate Tri-Lution™ (a patented probiotic manufactured by Agri-King, Inc.) on colostral immunoglobulin titers, calf blood immunoglobulin

titers and 60 d milk production. Pre-Fresh dairy cows (28 per treatment) were randomly assigned to one of two treatments starting three weeks before expected calving date. Treatments were a control ration or the same TMR containing 68 grams per head per day of Tri-Lution™. Following parturition all cows were fed the same milk cow ration (i.e. Tri-Lution™ feeding stopped at parturition). Colostrum was collected at milking and frozen. A 50 ml aliquot was used to measure immunoglobulin (IgG, IgM, and IgA) titers. Blood from new born calves was collected the day following consumption of colostrum and analyzed for IgG titers. Milk production, components, and SCC were monitored for the first 60 days after parturition on a weekly basis. Milk data was analyzed using two different time periods. Period 1 consisted of 0 to 30 DIM and period 2 from 30 to 60 DIM. Feeding Tri-Lution™ resulted in similar IgG and IgM titers in colostrum. However, colostral IgA titers were significantly higher when Pre-Fresh cows were fed Tri-Lution™ (625 vs 892 mg/100 ml for the control and Tri-Lution™ treatments, respectively, $P < 0.05$) compared to cows fed the control TMR. Serum IgG titers in the calves were similar between treatments the day following colostrum consumption. The SCC of milk from control cows increased 6% from period 1 (199,000 cells/ml) to period 2 (211,000 cells/ml), while the SCC from Tri-Lution™ fed cows decreased 47% (262,000 to 138,000 cells/ml) over the same time period, although the differences were not statistically significant ($P < 0.10$). This study demonstrated that Pre-Fresh dairy cows fed Tri-Lution™ before calving have lower SCC during the first 60 DIM compared to cows fed the control TMR. Feeding Tri-Lution™ to Pre-Fresh dairy cows enhanced colostral IgA concentrations

Key Words: Tri-Lution™, Immune, Dairy

W132 Effect of feeding red clover or ryegrass silage to dry dairy cows on nitrogen balance and blood metabolites. J. M. Moorby*¹, P. H. Robinson², and R. T. Evans¹, ¹*Institute of Grassland and Environmental Research, Aberystwyth, UK*, ²*UCCE, Dept. of Animal Science, University of California, Davis.*

To investigate the effect of feeding a high protein forage to dry cows on N partitioning and blood metabolites during the dry period (DP), and on subsequent lactational performance, 48 Holstein-Friesian dairy cows were offered ad libitum access to either red clover silage (RC; 22.4% DM, 18.9% crude protein [CP]) or ryegrass silage (RS; 28.0% DM, 17.2% CP) for the last 4 wk of the DP. After calving, all cows received the same diet of ad libitum ryegrass silage (29.2% DM, 18.1% CP) with a grain based concentrate (24% CP) at 6 kg/d. A subset of 2 cows per treatment were housed in a metabolism unit for 6 to 8 d of N partition and feed digestibility measurements at about 2 wk before calving, and 3 wk after calving. Blood samples were collected from all cows for metabolic profile measurements at wk 1, 3, 5, 7 and 9 of lactation. Before calving, N intake was higher ($P < 0.01$) in RC cows (376 vs. 349 g N/d), but apparent N digestibility was lower (60.7% vs. 66.8%; $P < 0.001$) so that feces N output was higher. There was no difference in urine N output due to DP treatments, nor whole body N balance (mean 58 g N/d). Whole tract DM digestibility was lower ($P < 0.001$) in RC (62.6% vs. 73.2%). After calving, there was no effect of the prior DP treatment on feed N partitioning or N balance. Mean whole tract diet DM digestibility was 62.2%. Plasma albumin concentrations tended to be higher ($P < 0.1$) in cows fed the DP diet based on RS (44.8 vs. 46.8 g/l), but there were no differences in plasma concentrations of urea, glucose, BHBA or NEFA. The N supplied by the DP diet of RC was used less efficiently than that of the RS, and so the digestible N supply to the cows during the DP did not differ between treatments. Lower plasma albumin concentrations in RC cows after calving indicate a smaller body protein pool than that of RS cows, despite similar N balances during the DP, indicating increased fetal N utilization.

Key Words: Digestibility, Nitrogen Partitioning, Plasma Metabolites

W133 Estimations of milk production by the NRC and the Cornell models when ruminal N balance was negative and MP was limiting. H. Kajikawa*¹, T. Koga², S. Ishizaki³, H. Shinohara⁴, K. Akutsu⁵, S. Sato⁶, K. Shimizu⁷, T. Tamura⁸, and M. Seki⁹, ¹*Natl. Inst. Livest. Grassl. Sci., Tsukuba, Ibaraki, Japan*, ²*Nagano Anim. Ind. Exp. St., Japan*, ³*Chiba Pref. Livest. Res. Center, Japan*, ⁴*Gunma Anim. Husbandry Exp. St., Japan*, ⁵*Tochigi Pref. Dairy Exp. Inst., Japan*, ⁶*Aichi-ken Agric. Res. Center, Japan*, ⁷*Yamanashi Pref. Dairy Exp. St., Japan*, ⁸*Tokyo Metropolitan Livest. Exp. St., Japan*, ⁹*Niigata Livest. Res. Center, Japan*.

A mechanistic approach has been adopted by several models (NRC, CNCPS) for more accurate nutritional estimations for high producing cows. Since we found that evaluation by the NRC model (dairy cattle, 2001) sometimes showed a lower value than actual milk production, we tried to analyze the factor of the underestimation by comparing with the CNCPS model (ver. 5, 2003). Four groups of multiparous cows (17 to 20 cows for each group) were assigned to diets with different CP and RDP levels having timothy hay, alfalfa hay, corn grain, cottonseed, beet pulp, soybean meals (or soy PLUS), and several other by-product feeds. Actual DMI, and milk composition (fat, protein) were input into the model, but the tabular values in each model were used for the feed compositions except the forage CP contents. Actual milk yield during 15 weeks after parturition was around 40 kg/d for each group. Body weight slightly increased during the experiment (5 to 20 kg). For the CNCPS evaluation, ME was always limiting for the production, and ME allowable milk correctly predicted the actual yield (0.2 to 1.2 kg/d of difference). For the NRC evaluation, however, MP was limiting for 3 groups (B, C and D), and MP allowable milk was below the actual yield (4.1 to 8.1 kg/d lower). For these groups, estimations of MP from bacteria by the NRC model were lower than those by the CNCPS model, and these lower values could be mainly attributed to the exclusion of the recycled N from the NRC model. Even endogenous MP, a new additional parameter of the NRC model, could not compensate for it. These results suggest that the NRC model would underestimate milk yield when the ruminal N balance is negative and MP is limiting.

Table 1. Estimations of milk production by the NRC and CNCPS models

		Cow group			
		A	B	C	D
NRC					
(dairy cattle, 2001)	ME allowable milk (kg/d)	40.8	41.7	40.8	38.7
	MP allowable milk (kg/d)	47.1	38.2	34.0	31.3
	MP - Bacterial (g/d)	1334	1226	1192	1157
	MP - RUP (g/d)	1452	1149	1059	1060
	MP - Endogenous (g/d)	116	116	117	113
	Ruminal N balance (g/d)	40	-29	-40	-38
CNCPS					
(ver. 5, 2003)	ME allowable milk (kg/d)	39.7	41.5	41.0	39.7
	MP allowable milk (kg/d)	49.9	45.8	41.0	41.2
	MP - Bacterial (g/d)	1583	1604	1572	1518
	(MP from recycled N, g/d)	202	316	345	321
	MP - RUP (g/d)	1496	1253	1142	1182
	Ruminal N balance (g/d)	70	-16	-47	-43
Actual Milk yield (kg/d)		40.9	42.3	40.6	39.5

W134 Prediction of nutrient supply to dairy cows from concentrates: Comparison of the National Research Council-2001 model with the Dutch system (DVE/OEB). P. Yu*, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Canada.*

The objective of this study was to compare the DVE/OEB system (DVE = truly absorbed protein in the small intestine; OEB = degraded protein balance) and the NRC-2001 model in the prediction of supply of protein to dairy cows from selected concentrates: malting-type barley (cv. Harrington), feed-type barley (cv. Valier), field tick beans (Vicia faba), white albus lupines (Lupinus albus), whole soybeans and horse beans (Vicia faba cv. Alfred). The two barleys were processed by coarse (Roller miller, 0.533 mm gap) and fine (Hammer mill, 2 mm screen) processing. The field tick beans and white albus lupines were dry roasted at various conditions. The soybeans and horse beans were pressure-toasted at the temperature 100, 118, 136°C for 3, 7, 15 and 30 min at

Wageningen Processing Centre. Comparisons were made in terms of 1) ruminally synthesized microbial protein, 2) truly absorbed protein in the small intestine, and 3) degraded protein balance, based on 46 samples. The results showed that the predicted values from the DVE/OEB system and the NRC-2001 model had significant correlations with. However, using the DVE/OEB system, the overall average microbial protein supply based on available energy was 10% lower and the truly absorbed protein in the small intestine was 8% lower than that predicted by the NRC-2001 model. The difference was also found in the prediction of the degraded protein balances, which was 16% higher than that estimated based on data from the NRC-2001 model. These differences are due to considerably different factors used in calculations in the two models, although both are based on similar principles. This indicates that a further refinement is needed for a modern protein evaluation and prediction system.

Key Words: NRC Dairy Model, DVE/OEB System, Protein Evaluation

Production, Management and the Environment: Nutrition and Environment

W136 Application of manure screening as an on farm a tool to evaluate the animal / diet interface. M. J. Jerred*¹, T. G. Brion¹, S. R. Burghardi¹, K. A. Ruppel², and M. A. Messman¹, ¹Cargill Animal Nutrition, Elk River, MN, ²Cargill Animal Nutrition, Albany, NY.

Animal performance is dependant on digestion of ingredients in the daily ration allotted to the animal. To better understand ration digestion on farm we have constructed a three screen manure separating apparatus for visual appraisal of manure. Manure evaluation along with knowledge of nutrient and particle size of the diet fed can help diagnose lack of conformance to nutrition model predictions. Sizes of the three screens are: 0.57, 0.31, and 0.16cm in diameter. A representative sample of fresh manure from eight to twelve cows in a pen of cattle is collected and washed through the series screens. Fecal samples from 29 commercial dairy farms were evaluated with the manure screener. The top screen averaged 18% (SE 1.6) by volume fecal particles, the middle screen averaged 30% (SE 4.5) by volume fecal particles and the bottom screen averaged 52% (SE 4.6) by volume fecal particles. On the top screen whole cottonseed, fiber particles and kernels of grain were typically observed. The middle and bottom screens typically contained fiber particles and co-product ingredients. To further evaluate the manure screener 4 no forage diets were fed. The top screen averaged 55% (SE 4.1) by volume fecal particles, the middle screen averaged 18% (SE 3.6) by volume fecal particles and the bottom screen averaged 27% (SE 2.6) by volume fecal particles. A T test was used to compare volume of particles retained on screens between normal and no forage diets. Feces from the no forage diet contained more ($P = 0.001$) particles on the top screen, fewer on the middle ($P = 0.052$) and bottom ($P < 0.001$) screens than diets that contained forage. Increased fecal particles in the top screen may have resulted from increased ruminal particle passage because of reduced ruminal mat formation when the no forage diet was fed. A tool to screen manure to evaluate passage of dietary ingredients can be an aid in determining the source of model non-conformance.

Key Words: Manure Evaluation, Digestion, Ration Evaluation

W137 Prediction of urine N excretion from creatinine and milk urea nitrogen in primiparous and multiparous cows. S.A. Flis* and M.A. Wattiaux, *University of Wisconsin-Madison*.

Urinary nitrogen (UN) excretion is an integral part of predicting N usage by an animal and formulating a farm N management plan. The objective of this research was to compare two UN prediction methods to observed values. Foley catheters were used to collect total urine excretion for 3 days from 8 lactating cows (4 multiparous and 4 primiparous) in a split-plot Latin square. Cows were fed one of four diets ranging from 0 to 20% excess N based on NRC 2001. Cows were weighed twice each period. The first prediction method was according to Kauffman

W135 Nutritive value of processed field tick beans predicted by two dairy models (NRC and DVE/OEB). P. Yu*¹, B. J. Leury², and A. R. Egan², ¹Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Canada, ²School of Agriculture and Food Systems, University of Melbourne, Australia.

The objective of this study was to compare the Dutch DVE/OEB system and the NRC-2001 model in the prediction of supply of protein to dairy cows from processed field tick beans. Comparisons were made in terms of 1) ruminally synthesized microbial CP, 2) truly absorbed protein in the small intestine, and 3) degraded protein balance. The results showed that the predicted values from the DVE/OEB system and the NRC-2001 model had significant correlations with high R (> 0.90) values. However, using the DVE/OEB system, the overall average microbial protein supply based on available energy was 16% higher and the truly absorbed protein in the small intestine was 9% higher than that predicted by the NRC-2001 model. The difference was also found in the prediction of the degraded protein balances (DPB), which was 5% lower than that predicted based on data from the NRC-2001 model. These differences are due to considerably different factors used in calculations in the two models, although both are based on similar principles.

Key Words: NRC-2001 Model, DVE/OEB System, Field Tick Bean

and St-Pierre, UN (g/d) = 0.0259 × BW (kg) × MUN (mg/dL). The second method was based on UN concentration multiplied by the urine volume (l/d) predicted as (2.9 × BW (kg))/(creatinine concentration in the urine). Both an AM and a PM spot sample of urine were used in predicting urine volume in this method. Cow BW ranged from 435 - 724 kg. The UN and volume predicted from both methods were lower in the primiparous cows ($P < 0.001$), but there was no parity by prediction method interaction ($P = 0.6$), indicating that the method of prediction is the same for both parity. Although the observed urine volume averaged 26.5 l/d, the predicted values averaged 34.7 l/d, for the PM samples, but 28.7 l/d for the AM samples. The PM prediction value was different from both the AM and the observed urine volumes ($P = 0.01$). The prediction of UN based on the AM and PM samples was 226 and 278 g/d respectively; with the observed UN at 208 g/d. Again the PM prediction of UN was different ($P = 0.01$) from both the AM and the observed values. In this trial, parity did not affect MUN, and the prediction of UN from MUN was 188 g/d. This prediction differed from the urine sampling methods ($P < 0.001$), but was not different from the observed values. These results suggest that the prediction of UN should be done from MUN values or AM samples of urine, but not PM samples. Diurnal variation, sampling time relative to feeding or other factors may have contributed to the bias in estimating UN from PM urine samples. MUN values are easier to obtain suggesting that the use of MUN to predict UN is the best approach.

Key Words: MUN, Creatinine, Urine Nitrogen

W138 Identifying dairy farms facing challenges in P management. V. A. Ishler* and L. E. Lanyon, *Pennsylvania State University, University Park*.

Reducing dietary P levels with the goal of minimizing P accumulation on dairy farms has been widely emphasized. Although there is opportunity to improve rations, this tactic alone may not solve the nutrient-loading problem for the most challenging situations, nor will it indicate when P accumulation is a problem. Herds required to comply with P-based nutrient management for crop production in the future or those planning expansions should look closely at the amount of P in manure that is or will be in excess of the local crop utilization potential. Herd size, ration composition, and ingredient source information was collected from eleven diverse Pennsylvania herds along with records of milk production. Accumulating P was determined by subtracting milk P (exported from the farm) and the home-grown crop P from total diet P. Dietary P on all eleven farms was very close to animal requirements, averaging 0.40% P (DM basis) with a range from 0.38% to 0.44%. However, purchased P ranged from 37% to 88% of the total P fed. Accumulating P (g/cow/d) was linearly related to percent purchased P, but was not related to diet P concentration. Farms with potential problems could be readily identified by this purchased P relationship. The ration P levels on farms with potential P problems were close to animal P requirements and not

different from the average. In this case, aggressively pursuing drastic ration changes to reduce dietary P concentration would have little impact on the accumulating P. The most appropriate tactic(s) for these farms may be beyond dietary changes and may rely on other whole farm strategies.

No. of farms	Accumulating P g/cow/day	Dietary P % DM basis	Purchased P %
1	0.0	0.40	37
1	4.5	0.41	40
1	9.1	0.41	46
4 ¹	13.6	0.38-0.44	45-56
1 ²	18.1	0.38-0.40	56-58
1	31.8	0.40	72
1	40.8	0.42	73
1 ²	49.9	0.41-0.42	88

¹Range of values for multiple farms.

²Herds with more than one lactating cow group.

Key Words: Phosphorus, Dairy, Manure

W139 The effect of TASC0 meal, on body temperature, respiration rate, horn flies, hair score and calf immunoglobulin levels in beef cows. R. R. Evans*, J. E. Huston, and T. F. Best, *Mississippi State University, Prairie, MS.*

Previous work with TASC0 seaweed meal (*Ascophyllum nodosum*), fed at the 10% level in a mineral to cows grazing Ky-31 fescue (*Festuca arundinacea*) infected with the endophyte *Neotyphodium coenophialum*, reduced rectal body temperatures (RBT) for cows and calves and cow respiration rate (CRR) and horn flies (HF). This trial was undertaken to determine if increasing the rate from 10% to 20% would further influence the effects measured in the initial trials. In January of 2002 and 2003, 45 days prior to calving, multiparous and primiparous cows were equally allotted by age, breed and weight into groups and fed minerals that included 0, 10 and 20% TASC0. Cows were fed infected fescue hay prior to grass putout and grazed infected fescue/mixed warm season perennial pastures. All values reported hereafter will be for inclusion rates of 0, 10 and 20%, respectively. Mineral consumption monitored weekly was not different ($P < 0.05$), 111.16; 111.72; and 111.44 g/h/d, with a targeted 112 g/h/d consumption. At birth calves were processed, a 5-ml blood sample drawn and serum collected to determine IgG levels utilizing a Single Radial Immunodiffusion Kit (VMRD, Inc). Samples were compared to a standard, 1=low to 4= high reactivity. Pooled IgG levels for 2002 and 2003 were not different ($P < 0.05$) at 3.320; 3.152; and 3.336. RBT recorded in July of 2002 were 40.25; 40.36; and 40.17 and for 2003, 38.99; 39.46; and 39.34 C, but were not different ($P < 0.05$). Mean RBT across groups was one degree less for 2003 than for 2002, reflective of cooler temperatures and higher rainfall in 2003. Calf weaning weights were not different ($P < 0.05$) between treatment groups for 2002 (232.90; 222.90; 229.33 kg) and 2003 (242.47; 259.98; 244.89 kg), respectively. CRR were taken at 0800, 0110 and 1500 h for 10 days in August and September were not different ($P < 0.05$) between treatments in either year. HF were not different ($P < 0.05$) between treatments within year but were reduced in 2003 vs. 2002. Hair scores for cows was improved but were not different ($P < 0.05$) with the addition of TASC0 at 10 and 20% but calf hair scores were not improved.

Key Words: TASC0, Seaweed, Fescue

W140 Efficacy of yeast ferment as urease inhibitor on controlling ammonia emission from manure slurry. S. Park*¹, S. Oh², and S. Kim¹, ¹*Division of Food Science, Korea University*, ²*Department of Animal Science, Chonnam University, Korea.*

Urease (urea aminohydase, EC 3.5.1.3) is a nickel-containing enzyme that hydrolyzes urea to form carbamate and ammonia; carbamate spontaneously degrades to CO₂ and a second molecule of ammonia. Ammonia causes unpleasant odor and is harmful to animal and human health. The purpose of this study was to evaluate the potential of yeast culture isolated from yeast ferments as an urease inhibitor. About 200 yeast strains were isolated from yeast ferments. Yeasts were incubated with anaerobic and aerobic conditions. The urease inhibitory activities of yeast supernatants were measured by pH indicator assay. Ammonia

contents in manure slurry was measured at anaerobic and aerobic incubations using indophenol method (Berthelot reaction). Six yeast isolates were shown to inhibit urease a ratio about 25-45%. Yeasts supernatant were incubated in anaerobic condition at 25C showed the highest urease inhibitory activities. However yeasts supernatant were incubated in aerobic condition with shaking at 200 rpm/min showed lower urease inhibitory activities than other condition. AHA (acetoxyhydroxyamic acid) and NBPT (n-(n-butyl)thiophosphoric triamide) were known to effective urease inhibitors. However AHA is too expensive to utilize as an ammonia reducing material and NBPT is unable to use animal feed additives. These results demonstrated the potential of yeast culture as an urease inhibitor which is capable of reducing ammonia in animal farms.

Key Words: Urease, Inhibitor, Yeast

W141 Benefits of reducing the volume of cleaning wastewater on large dairy farms. J. K. Diehl* and W. J. Harper, *The Ohio State University, Columbus.*

As dairy farms continue to become larger and more regulated, manure management becomes an ever increasing topic of concern for the farmer. In areas where manure and other wastes are stored and applied to the land when conditions allow, farms are challenged by undersized storage structures and the cost associated with hauling waste. One step in reducing the volume of manure stored would be to reduce the volume of milking center wastewater entering the storage structure. In order to come up with water reduction solutions, the amount of cleaning wastewater used must be known. Literature values for cleaning wastewater volumes are highly variable and likely based on small farms. This study evaluated the amount of milking center wastewater generated and the farmers knowledge of wastewater volumes on large dairy farms in Ohio. Forty four replies were received from a mail survey of the 80 known farms milking more than 290 head. Ten of those responding were visited for an assessment of cleaning water usage. The farms surveyed ranged in size from 290 to 2100 milking cows with a mean of 515 cows. Knowledge of water usage varied by farm. 50% of farmers did not know the volume of water required to clean the pipelines, 71% did not know the volume used to clean the bulk tank, and 84% did not know the volume used to clean the parlor. On 86% of the farms, the wastewater produced by cleaning the bulk tank and pipelines was not reused. Most farmers (75%) indicated reducing the volume of water entering their manure storage structure would be a benefit to their operation. The farms visited ranged in size from 320 to 1850 milking cows with a mean of 596 cows. The total volume of milking center wastewater produced per day ranged from 360 to 4,800 gallons with a mean of 1,303 gallons/farm/day. These farms averaged 475,705 gallons of wastewater per year from cleaning the pipelines and bulk tanks alone. The amount of wastewater produced from the milking center was shown to be 2 to 10 times higher than values found in the literature. The actual volumes found justify exploration of practices to reduce or reuse cleaning water, thereby reducing the total volume of water entering manure storage structures.

Key Words: Dairy, Wastewater

W142 Composting organic wastes from a commercial slaughter house in Puerto Rico. R. Sanabria-León*, A. A. Rodríguez, and H. L. Santiago, *University of Puerto Rico Mayagüez Campus, Mayagüez, PR.*

The objective of this study was to evaluate the composting process as an alternative for the disposal of organic wastes from commercial slaughter houses (OWCS), using yard trimmings (YT) as bulking agent. Digestive tracts of small ruminants (OWCS) and YT were obtained from a commercial slaughter house and the Alzamora Laboratory Farm of the University of Puerto Rico at Mayagüez, respectively. Three treatments were evaluated using 2:1 proportions (w/w): YT only (C); YT/OWCS in a single layer (YW), and YT/OWCS in double layers (YWW). Treatments were placed in composting bins of identical dimensions (3 cubic feet) and the moisture level adjusted to 60%. Temperatures were recorded daily to determine the time (d) needed by each treatment to reach the maximum temperature in each heat cycle. Composting characteristics such as: C:N ratio; OM and IM contents; and pH were measured at d 0, first and second heat cycles, and maturation of the composting process. The time needed to complete each cycle was also determined. Data was analyzed using a completely randomized design with a 3 (treatments) x 6 (composting phases) factorial arrangement of treatments. For the

entire composting process, pH was similar ($P < 0.05$) regardless of treatments and phases. The N content increased and C:N ratio decreased ($P < 0.05$) in all treatments during the entire composting process. In both heat cycles, thermophilic temperatures ($> 45^{\circ}\text{C}$) were reached in treatments containing OWSC. The C group was characterized by reaching mesophilic temperatures (25 to 45°C). At the beginning of the maturation phase, all OWCS were degraded; OM and the IM were higher ($P < 0.05$) in YW and YWW, respectively, compared to the C group. These results suggest that composting could be an alternative for the disposal of organic wastes from slaughter houses. Further studies are needed in order to evaluate its use as an organic fertilizer.

Key Words: Composting, Organic Wastes, Slaughter Houses

W143 Effects of pit flushing frequency on farrowing house odor and gas concentrations. J. M. Schlipf*, M. Ellis, J. Ni, Y. Zhang, A. Mutlu, and T. L. Funk, *University of Illinois, Champaign-Urbana*.

This study was carried out over a 15-d period to determine the effect of pit flushing on gaseous emissions from a farrowing facility. A randomized block design was used with six rooms selected from a 14-room farrowing complex with five replicates over time. Two treatments were compared: control and flushed. Pits were flushed before the start of the study only for the control treatment and before the start and on d 8 of the study for flushed treatment. Samples were collected one day after sows were moved into the room, (d 1) and on d 8, 9, and 15. Samples were taken inside the room at the exhaust fan and outside at the pit fan exhaust. For odor analysis, air samples were pumped into 10 L Tedlar sampling bags and subsequently assessed by an 8-member olfactometry panel. Ammonia and hydrogen sulfide concentrations were measured using colorimetric detector tubes. Fan speed (taken at the same time as gas measurements) were not different ($P > 0.05$) between control and treated rooms. For the control rooms, concentrations of odor, NH_3 , and H_2S in the exhaust air from room and pit fans increased from the start (d 1) to the end of the study (d 15); e.g., pit exhaust concentrations increased from 2.65 to 3.19 (SEM 0.071; $P < 0.001$) for odor units, from 1.27 to 2.75 (SEM 0.157; $P < 0.001$) for NH_3 , and from 0.13 to 0.97 (SEM 0.067; $P < 0.001$) for H_2S . On d 8, odor and gas concentrations were numerically lower after flushing the pit than before from the room and pit exhausts, however, only the H_2S levels were different ($P < 0.05$).

Beef Species: Management and Beef Performance

W145 Evaluation of SafeGuard® (fenbendazole) oral drench in addition to Ivomec® (ivermectin) pour-on on performance and carcass merit of finishing heifers. C. D. Reinhardt*, J. P. Hutcheson, and W. T. Nichols, *Intervet, Inc, Millsboro, DE*.

One thousand one hundred six English×Continental crossbred heifers (340 kg) were used in a randomized complete block study. Treatments were: 1) SafeGuard® (5 mg/kg BW) and Ivomec® pour-on (500 mcg/kg BW) day 0 (SGPO), and 2) Ivomec pour-on (500 mcg/kg BW) day 0 (PO). There were 8 pens per treatment with an average of 69 head per pen. Heifers were fed for 135 days. Heifers treated with SGPO had 73% ($P = 0.06$) and 68% ($P = 0.06$) fewer eggs per 3 g fecal sample at d98 post-treatment and at the end of the feeding period than heifers treated with PO. Heifers treated with SGPO had higher dry matter intake, higher average daily gains, heavier final weight, and heavier carcass weights than heifers treated with PO alone ($P < 0.05$). Percentage of carcasses grading Prime+Choice was higher ($P = 0.07$) and marbling score tended to be higher ($P = 0.13$) for heifers treated with SGPO vs. heifers treated with PO alone. These data indicate that feed intake, daily gain, carcass weight, and carcass quality of feedlot heifers can be improved using fenbendazole in conjunction with ivermectin pour-on compared to using ivermectin pour-on alone due to improved parasite reduction of the combined treatment protocol.

Trt	Egg ct ²	Carcass-adjusted performance ¹				
		ADG,kg	DMI,kg	G:F	HCW,kg	Pr+Ch,%
SGPO	3 ^a	1.53 ^c	8.12 ^c	.190 ^c	337 ^c	47.9 ^a
PO	12 ^b	1.47 ^d	7.93 ^d	.187 ^d	332 ^d	42.6 ^b

¹ HCW divided by .6193; ² eggs/3g sample d98 post-trt
a,b differ ($P < .10$)^{c,d} differ ($P < .05$)

Key Words: Fenbendazole, Feedlot, Parasites

Concentrations of H_2S 4 h before and 4 h after flushing were 0.54 and 0.10 ppm, (SEM 0.119) respectively, in the room exhaust, and 0.87 and 0.24 (SEM 0.125) ppm, respectively, in the fan exhaust. However, at the end (d 15) odor and gas levels were similar in the control and flushed rooms. Overall, results suggest that flushing the pits in this farrowing facility had a limited, short-term effect on odor, NH_3 , and H_2S concentrations.

Key Words: Pigs, Odor, Gaseous Emissions

W144 Evaluation of round bale feeding sites on soil fecal bacteria and nutrient concentrations. N. A. Lenehan, J. M. DeRouchey*, T. T. Marston, M. L. Christian, and G. L. Marchin, *Kansas State University, Manhattan*.

An experiment was conducted over seven months (January to July, 2003) to evaluate fecal bacteria and nutrient concentrations in soil surrounding round bale feeders. Six-inch soil samples were taken monthly from 10 feeding sites at distances of 3, 12, 21, and 30 m from the feeder. Soil samples were taken prior (January) to livestock access to the sites, during (February, March, and April) the feeding period, and after (May, June, and July) cattle removal from the sites. Fecal *E. coli* concentrations reached their highest levels in April at distances of 3 and 12 m, and were greater ($P < 0.03$) than all other months except March. At 21 and 30 m from the feeder, fecal *E. coli* concentrations were greater ($P < 0.01$) in April than all other months. At a distance of 3 m from the feeding area, fecal *streptococci* concentrations were greater ($P < 0.01$) in March and April compared to all other months. While fecal *E. coli* concentrations in July had returned to levels similar to that in January, fecal *streptococci* remained at higher levels ($P < 0.05$). For soil nutrients tested, the greatest increase generally occurred at 3 m from the feeders, with little differences thereafter. The highest level of soil phosphorus at 3 m was recorded in April, and concentrations exceeded ($P < 0.02$) those in January, February, and May. Soil dry matter had quadratic decreases ($P < 0.02$) in March, April, and July, and linear decreases ($P < 0.01$) in May and June as the distance from the feeding area decreased. Results indicate that the immediate area surrounding round bale feeding sites should be cleaned of manure, wasted feed, or bedding following cattle removal to reduce environmental impacts.

Key Words: Feeding Sites, Fecal Bacteria, Environment

W146 Examination of reproduction and weaning results in Limousin cattle population in Hungary. F. Szabo*¹, Z. Lengyel¹, S. Balika², I. Erdei¹, D. Marton¹, T. Major¹, and S. Bene¹, ¹University of Veszprem Georgikon Faculty of Agriculture, Hungary, ²Hungarian Limousin Association, Budapest, Hungary.

Weaning performance, gestation length and calving difficulty of 2555 purebred calves (1305 male and 1250 female) born from 713 cows mated with 43 sires were analyzed in two farms. Heritability, repeatability, breeding value, genetic and environmental variance of weaning weight (VS), preweaning daily gain (SGY), 205-day weight (KVS), gestation length (VI), calving difficulty (EL) the genetic, phenotypic and environmental correlation between VS and SGY were calculated. The genotype-environment interaction was analysed with method of rank correlation. Farm, year of birth, season of birth, sex, number of calving as fixed, while sire as a random effect was treated. Data were analyzed with Harveys (1990) Least Square Maximum Likelihood Computer and SPSS 9.0. The overall mean value and standard error of VS, SGY, KVS, VI and EL were 208 ± 5.29 kg, 997 ± 24.50 g/day, 205 ± 5.54 kg, 285 ± 1.54 day and 0.97 ± 0.03 , respectively. The average age of the analysed calves was 211 days. The heritability of traits was between 0.10 and 0.44. The genetic, phenotypic and environmental correlation between VS and SGY was strong and positive. The rank correlation values were low in the case of the investigated traits ($r = 0.05-0.27$), therefore the order of sire rank were different in the two farms.

Key Words: Weaning Wt, Heritability, Correlation

W147 Predictors of the final carcass grades in crossbred steers. K. Uetake^{*1}, T. Ishiwata¹, N. Abe², Y. Eguchi¹, and T. Tanaka¹, ¹*School of Veterinary Medicine, Azabu University, Sagami-hara, Japan*, ²*Faculty of Agriculture, Tamagawa University, Machida, Japan*.

To determine the predicting parameters for the final carcass grades, 35 Japanese Black × Holstein steers aged 6-10 mo were followed up until slaughter. They were allocated to three pens (6.0 m × 9.5 m each) and fed with commercial grain feed. The steers were allowed to access dry hay or oat straw on an ad libitum basis in the early (E) or middle (M) fattening stage. Behavioral observations (15 categories) for 2 h after morning and evening feedings were performed every 2 mo. BW measuring, blood sampling (7 hormones and 5 metabolites), ultrasonic scanning and physical measuring (10 parts) were conducted after the morning observation. Temperament scores during these handling procedures, entry order into a crush, social rank and ADG were assessed. Carcass grades were obtained after the slaughter. A principal factor analysis with the Harris-Kaiser rotation extracted 11 and 10 clusters in the E and M stages. One-way ANOVA determined clusters in which their factor scores were different between the carcass grades: In the E stage, they were a cluster of chest girth (loading 0.90) and depth (0.88), body weight (0.86), withers (0.84) and hip (0.79) height and rump length (0.77) ($P < 0.01$), and a cluster of the number of scratching their head or neck with facilities (0.92) ($P < 0.05$) for the carcass yielding grades; a cluster of social rank (0.73) and triglyceride concentrations (0.62), and a cluster of the numbers of investigating facilities (0.65) and eating hay (-0.86) (both $P < 0.10$) for the carcass quality grades. In the M stage, they were a cluster of cortisol (0.84) and adrenaline (0.60) concentrations, and the number of eating hay (-0.67) ($P < 0.10$) for the carcass yielding grades; a cluster of hip height (0.87), body weight (0.71), cannon circumference (0.69), chest depth (0.62), withers height (0.57) and chest girth (0.55) ($P < 0.10$), and a cluster of the number of eating grain feed (0.91) and stand-chewing the cud (-0.61), and social rank (-0.66) ($P < 0.10$) for the carcass quality grades.

Key Words: Beef Cattle, Carcass Grades, Prediction

W148 Evaluation of implant strategy and days on feed on performance and carcass merit of finishing yearling steers. J. P. Hutcheson^{*1}, W. T. Nichols¹, C. R. Reinhardt¹, S. R. Swingle², and K. J. Karr², ¹*Intervet, Inc., Millsboro, DE*, ²*Cactus Research, Ltd, Amarillo, TX*.

One thousand nine hundred and eighty-eight head of crossbred, yearling steers (383 kg) were used in a randomized complete block experiment with a 2 × 2 arrangement of treatments to evaluate the effect of implant type and days on feed. Implant treatments were 1) Revalor-S (120 mg trenbolone acetate + 24 mg estradiol) implanted on day 0 only (RS); 2) and Revalor-IS (80 mg trenbolone acetate + 16 mg of estradiol) implanted on day 0 only (IS). Steers were fed 123 or 145 days. There were 5 pens per treatment with an average of 98 head per pen. Steers implanted with RS had higher ($P < 0.05$) live and carcass adjusted average daily gain at both days on feed when compared to IS implanted steers. Daily dry matter intake tended ($P = 0.07$) to be greater in RS steers fed 123 days compared to IS implanted steers. Feed conversion was improved ($P < 0.05$) in RS implanted steers fed 145 days compared to IS implanted steers, but was not different in steers fed 123 days. Hot carcass weight was greater ($P < 0.05$) in RS implanted steers at 123 days on feed compared to IS steers. Steers fed 145 days, had lower average daily gain, higher feed to gain and greater final weight compared to steers fed 123 days ($P < 0.05$). There were no differences in quality or yield grade measurements between implant treatments at either slaughter time. However, feeding steers implanted with RS an additional 22 days did increase the percentage of Choice & Prime carcasses from 48 to 56%. Cattle fed 145 days had a higher dressing percent, greater carcass weight, more rib fat, higher average yield grade and more empty body fat (EBF) compared to cattle fed 123 days ($P < 0.05$). There were no differences in quality grade by days on feed. Feeding cattle an additional 22 days increases out weight and carcass weight with a reduction in average daily gain and increased feed to gain without affecting quality grade. Implanting yearling steers one time with RS provides improved performance without compromising quality grade when compared to steers implanted with IS at either slaughter time.

Animal Performance and Carcass Traits

Days on Feed	123	123	145	145	P-value	P-value	P-value
Implant Type	IS (1)	RS (2)	IS (3)	RS (4)	1 vs 2	3 vs 4	1,2 vs 3,4
In Wt	385	383	385	381	.34	.13	.58
Out Wt	601	606	630	634	.08	.27	<.01
ADG, kg	1.75	1.81	1.69	1.74	<.01	.04	<.01
DMI, kg	9.62	9.83	9.71	9.67	.07	.66	.63
Feed:Gain	5.51	5.43	5.75	5.57	.30	.03	<.01
HCW, kg	385	390	407	410	.03	.15	<.01
Pr+Ch, %	53.0	48.3	57.0	56.4	.46	.93	.20
EBF, %	29.9	29.6	30.8	29.8	.16	.46	<.01

Key Words: Implants, Feedyard, Steers

W149 Comparison of weaning and yearling ultrasonic measures of body composition in Angus breeding cattle. T. Perkins^{*} and A. Rimal, *Southwest Missouri State University, Springfield*.

The objectives of this study were to assess the relationship between ultrasound measurements taken at weaning and yearling weigh periods. One hundred seventy-five registered Angus bulls (n=88) and heifers (n=87) were scanned ultrasonically for ribeye area, fat thickness, percent fat (for the equivalent to marbling score) and rumpfat prior to weaning and again at approximately one year of age. The cattle used in this study were from the Falcon Seaboard Ranch located in Fredericksburg, Texas. Ultrasound values at weaning were then compared to measurements taken at approximately one year of age. All ultrasound measurements were taken by an Ultrasound Guidelines Council (UGC) field and laboratory certified technician, at weaning and yearling, using the Beef Image Analysis (BIA) software. Weaning images were processed by the scanning technician whereas yearling images were interpreted by the National CUP Lab in Ames, Iowa. Weanling means for scan weight (WSW), ribeye area (WREAU), fat thickness (WFTU), percent fat (WPFU), and ribeye shape (WREAS) were 291.9 ± 33.42 kg, 53.78 ± 7.45 cm², .42 ± 0.24 cm, 3.90 ± .67 %, and 2.50 ± 0.73, respectively. Yearling means for scan weight (YSW), ribeye area (YREAU), fat thickness (YFTU), percent fat (YPFU), and rump fat (YRFU) were 469.4 ± 61.39 kg, 66.45 ± 10.49 cm², .64 ± 0.20 cm, 4.54 ± 1.27 %, and .78 ± 0.23 cm, respectively. Pearson correlations for WSW and YSW, WPFU and YPFU, WREAU and YREAU were 0.57, 0.52, and 0.55, respectively; whereas, the correlation between WFTU and YFTU were lower and non significant at 0.16. These coefficients indicate that the relationship between weaning and yearling carcass attributes for scan weight, percent fat, and ribeye area were high and statistically significant. However, these results indicate that ultrasound was not a useful tool in assessing external fat levels on weanling calves prior to going into a performance testing program.

Key Words: Ultrasound, Weaning, Beef

W150 Effects of an artificial sweetener (Sucram C-150) on performance and health of newly received beef cattle. J. D. Rivera^{*1}, J. T. Richeson¹, M. L. Galyean¹, W. Rounds², and P. Schlegel³, ¹*Texas Tech University, Lubbock*, ²*Prince Agri Products, Inc., Quincy, IL*, ³*Pancosma, Geneva, Switzerland*.

Two hundred crossbred (British x Continental) beef steers (average BW = 190.1 ± 4.07 kg) were shipped 1,588 km from an order buyer facility in West Point, MS to the Texas Tech University Burnett Center in New Deal, TX and used in a randomized complete block design to evaluate the effects of an artificial sweetener (Sucram C-150; Pancosma, SA) added to the diet on performance and health for a 60-d receiving period. On arrival, cattle were vaccinated for respiratory disease and clostridial antigens, given a unique ear tag, weighed, dewormed, and assigned to one of two treatments: 1) Control: a standard 65% receiving diet; or 2) Sucram: a standard 65% receiving diet with 200 mg/kg (DM basis) of Sucram C-150 artificial sweetener. Following processing, cattle were moved to their assigned pens, and offered the receiving diet free choice. Long-stemmed sorghum sudangrass hay (1.81 kg/animal, DM basis) was fed for the first 5 d only. Cattle were observed daily for symptoms of bovine respiratory disease (BRD), and treated as needed when rectal temperature was > 39.7 °C. Sucram C-150 did not affect ($P > 0.10$) DMI at any time in the 60-d study, nor, did it affect ADG from d 0 to

14; however, feeding Sucram tended ($P < 0.12$) to increase 28-d ADG (1.43 vs. 1.50 kg/d for Control and Sucram, respectively) and increased ($P < 0.10$) ADG for the overall 60-d period (1.24 vs. 1.33 for Control and Sucram, respectively). Gain efficiency did not differ between treatments, except from d 0 to 28 ($P < 0.02$), when Sucram improved G:F. No differences were detected ($P > 0.10$) for morbidity between the two treatments (59.7% and 58.0% for Control and Sucram, respectively); however, feeding Sucram decreased ($P < 0.02$) the proportion of animals requiring two or more antibiotic treatments (52.6% and 41.0% for Control and Sucram, respectively). The addition of 200 mg/kg (DM basis) Sucram C-150 to the diet of newly received cattle increased receiving period ADG and resulted in fewer repeat antibiotic treatments to recover from BRD.

Key Words: Artificial Sweetener, Beef Cattle, Diets

W151 Effect of shade in feedlot pen on growth performance response of finishing beef cattle the cold season in the northwest of Mexico. R. Barajas^{*1}, B. J. Cervantes¹, R. J. Virgilio², and P. Castro², ¹FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan (Mexico), ²Tecnologia de Maxima Produccion S.A. de C.V., Mexico.

To determine the effect of shade in feedlot pen on growth performance response of finishing beef cattle the cold season in the northwest of Mexico, a 63-d feedlot performance experiment was conducted from January to March of 2003. Sixty-six brahman crossed bull calves (Males, BW=370.14±4.28 kg), were used in a complete block randomized experimental design. The animals were blocked by initial weight, and placed in ground pens (6 x 12 m), the treatments consisted in: 1) Pens without shade (Control); or pens fitted with roof that provides 3 m² of shade by animal (Shade treatment). Animal were fed with 14.86 forage:concentrate, cracked corn based diet containing CP 14%, NEm 1.85 Mcal/kg, and NEg 1.22 Mcal/kg. Mean temperature was 22.4°C and total precipitation was 14.2 mm. Shade increased ($P < 0.01$) 4% final weight (432 vs. 482 kg), and 16% average daily gain (1.50 vs. 1.74 kg/day). Dry matter intake was not affected ($P = 0.58$) by treatments (10.41 vs. 10.14 kg/day). Feed conversion was improved ($P < 0.01$) by use of shade (6.94 vs. 5.84). Carcass weight increased ($P < 0.01$) 5.7% by shade inside of pen (294.10 vs. 310.95 kg). Carcass dressing was not affected ($P = 0.29$) by treatments (64.5 vs. 63.9%). NEM obtained from the diet was improved ($P = 0.02$) by shade (1.866 vs. 2.127 Mcal/kg), and NEg was increased ($P = 0.02$) with shade in pen (1.226 vs. 1.455 Mcal/kg). Observed/expected NEM ratio was 14% higher ($P = 0.02$) in shade treatment (1.01 vs. 1.15), and observed/expected NEg was increased ($P = 0.02$) 18% by shade (1.01 vs 1.19). It is concluded, that the use of shade inside of feedlot pen improves growth performance response of finishing beef cattle in the northwest of Mexico.

Key Words: Shade, Growth-Performance, Beef Cattle

W152 Effect of hormonal implant failure on growth performance response of finishing beef cattle re-implanted during raining hot season in the northwest of Mexico. R. Barajas^{*1}, B. J. Cervantes¹, R. J. Virgilio², and P. Castro², ¹FMVZ-Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico, ²Tecnologia de Maxima Produccion S.A. de C. V., Mexico.

The objective was to determine the effect of hormonal implant failure on growth performance response of finishing beef cattle re-implanted during raining hot season in the northwest of Mexico. A 73-d feedlot performance experiment was conducted from September to December of 2003. Ninety four brahman crossed bull calves (Males, BW=335±4.74 kg), were used in a complete block randomized experiment design. Calves from a 91-d growing period were weighed and reimplanted in the left ear with Revalor. Calves were placed in 12 ground pens and fed finishing diets for 73 d. Calves were harvested and left ear was obtained to evaluate implant condition. Implant condition criteria were: 1) Absorbable implant (Normal, Brocket, etc.); or 2) Not absorbed implant (Encapsulated, Absessed, and not found). Implants in 31 calves were considered as not absorbed. Thirty d prior to implantation, the mean temperature at 14:00 hours was 33.5 °C, relative humidity was 60.41%, and precipitation was 252 mm. Ending weight was not affected ($P = 0.22$) by implant condition. Body weight gain was decreased ($P < 0.05$) in 9% by loss or implant activity (98.02 vs. 89.49 kg), and average daily gain was diminished ($P < 0.05$) in 5.5% (1.33 vs 1.26 kg/day). Carcass

weight, dressing, marbling score, KPH fat, and meat color were not affected ($P > 0.10$) by implant condition. Carcass grading was higher ($P < 0.05$) for carcass from animals with implant failure. It is concluded, that under raining hot condition, implant failure can be high and this negatively affects weight gain in finishing beef cattle. #8482#8482

Key Words: Hormonal Implants, Growth Performance, Beef Cattle

W153 Long term comparative trial of ear tags and ceramic boluses for the electronic identification of beef cattle under European rangeland conditions. J. J. Ghiradi^{1,2}, G. Caja¹, C. Conill¹, M. Hernández-Jover^{*1}, and D. Garín^{1,3}, ¹Universitat Autonoma de Barcelona, Spain, ²Universidad Nacional del Litoral, Esperanza, Argentina, ³Universidad de la Repblica, Montevideo, Uruguay.

A herd of Bruna dels Pirineus beef cows (n = 161) grazing under European rangeland conditions in the Pyrenees Mountains was used to compare two type of electronic identification devices for a period of 7 years (1997-2003). All cows wore two officially approved plastic ear tags with two flaps numerically and barcode recorded by laser (weight, 6 g; Azasa-Allflex, Madrid, Spain), according to the European Regulation for cattle identification (CE 1760/2000), and were also identified with two types of ISO half-duplex radio frequency devices: 1) electronic button ear tags (weight, 10 g; o.d., 30 mm; Allflex, Vitré, France) attached to the left ear; and, 2) electronic ceramic ruminal boluses (weight, 75 g; length×o.d., 21×68 mm; specific gravity, 3.36; Gesimpex, Barcelona, Spain). Reading controls of all devices were carried out at the annual brucellosis and tuberculosis testing and parasites drugging. Electronic devices were read using a Gesreader 2S hand-held reader (Gesimpex). A total of 3 cows died and 95 cows were slaughtered during the experiment. After 7 years, the 63 cows remaining in the herd retained 94.4% of the officially approved plastic ear tags (0.8% annual loss rate). Only 28.6% of tags were read by mean of a barcode reader (Intermec M90, Everett, WA) without immobilizing the head of the cows. Electronic ear tags showed a 96.8% readability (1.5% failed and 3.2% lost). Two electronic boluses (1.2%) were lost 2 h after application and were reapplied on the same day. No new losses or failures of boluses occurred during the experiment. In conclusion, electronic identification proved to be more efficient than conventional ear tagging in beef cows. Long term readability was greater for boluses than ear tags, recommending their use for cattle electronic identification under European rangeland conditions.

Key Words: Electronic Identification, Bolus, Ear Tag

W154 Comparison of pre-yearling, yearling, and post-yearling ultrasonic measurements of body composition in Brahman bulls. T. D. Jennings^{*1}, T. Perkins¹, and J. C. Paschal², ¹Southwest Missouri State University, Springfield, ²Texas A&M University, Corpus Christi.

The objective of this study was to compare ultrasonic measures of body composition in Brahman cattle at various stages of development. There were three individual scan sessions taken on the Brahman bulls (N=72). Individual weights and ultrasonic measurements for ribeye area, fat thickness, percent intramuscular fat and rumpfat were taken during three measurement intervals. The serial measurements were taken every two months (beginning mean age of 11 months and mean ending age of 15 months). The animals used in this study were provided by the J. D. Hudgins Ranch in Wharton, Texas. All ultrasound measurements were taken by an Ultrasound Guidelines Council (UGC) field and laboratory certified technician. Beef Image Analysis (BIA) software was used for the data collection. Pre-yearling, yearling, and post-yearling images were collected and interpreted by the same technician. A positive and significant correlation existed between all pre-yearling, yearling, and post-yearling ultrasonic measurements of body composition within each specific trait (e.g. FTU1 and FTU2 = 0.542; FTU1 and FTU 3 = 0.598; FTU2 and FTU3 = 0.635). Significant correlations existed between post-yearling weight (WT3) and post-yearling ultrasound measures of ribeye area (REAU3), fat thickness (FTU3), and rumpfat (RFU3) (0.676, 0.432, and 0.408, respectively). The correlation between post-yearling percent intramuscular fat (%FatU3) and WT3 was low (-0.05) and non-significant as well as the correlation between %FatU3 and REAU3 (0.013). The correlations between REAU3 and FTU3, and REAU3 and RFU3 were 0.314 and 0.281, respectively. A moderately positive correlation existed between FTU3 and %FatU3 (0.262). These data suggest that ultrasound was effective in measuring changes in body composition traits of external fat thickness, ribeye area and rumpfat.

However, the technology was ineffective in measuring differences in intramuscular fat deposition in pre-yearling, yearling, and post-yearling Brahman bulls.

Key Words: Ultrasound, Brahman, Seriel

W155 Cow-calf efficiency of four different dam genotypes. L. Calegare¹, M. M. Alencar², G. M. Cruz², and D. P. D. Lanna*¹, ¹*Animal Growth and Nutrition Lab. ESALQ/USP, Piracicaba, SP, Brazil*, ²*Brazilian Southeast Cattle Research Center, Brazil*.

Brazil has 53 millions beef cows, 85% of which from the Nelore breed. However there are no data comparing biological efficiency of Nelore and its crosses with *B. taurus*. The objective of this study was to determine cow-calf efficiency. Forty cows from four genotypes Nelore (NL), Canchim x Nelore (CN), Angus x Nelore (AN), and Simmental x Nelore (SN) were randomized in blocks by calving date. Cows and respective calves were individually fed from postpartum to weaning (15-180 d) a 50:50 hay:concentrate diet (16% CP and 2.34 Mcal ME on a DM basis), adjusted weekly to maintain body weigh and condition score. Calves received the same diet of their dams *ad libitum*, beginning at 40 d of age. Crossbred cows were bred to Canchim (5/8 Charolais) bulls and NL cows to Nelore bulls. Milk yield was estimated by weighing calves before and after suckling. ME intakes by cow/calf units were different ($P < 0.05$); 4139.1±78.7 for SN, 3898.2±78.7 for AN, 3777.8±78.7 for CN and 3523.5±78.7 Mcal for NL. The energy intake was parallel to adult body weight, milk yield and calves growth rate. At weaning empty body weight for NL calves was lower ($P < 0.05$) than crossbred calves; 149.1±9.3 vs. 201.3±9.3 for 1/4S, 192.8±9.3 for 1/4A and 183.1±9.3 kg EBW for 3/4C. Body composition was estimated by 9-10-11th rib analysis. Energy retention (Mcal) was higher ($P < 0.05$) for 1/4A than 3/4C and NL; 462.6±28.8 vs. 384.0±28.8 and 321.8±28.8 Mcal, respectively. Calves 1/4S had intermediate energy retention; 429.8±28.8 Mcal. Cow-calf efficiency was higher ($P < 0.05$) for AN compared to NL cow-calf pairs; 113.6±7.1 vs. 88.9±7.1 kcal/Mcal. Results for Simmental and Canchim pairs were intermediate; 99.2±7.1 and 98.8±7.1 kcal/Mcal, respectively. The higher ME intakes by AN cow-calf pairs were compensated by the higher energy retention and EBW gain. Reproduction was not evaluated, but under unrestricted nutritional conditions cross-breeding improved cow efficiency as measured by proportional energy retention in their calves.

Key Words: Weaning Weight, Body Composition, Biological Efficiency

W156 Efficacy and persistency of pour-on dewormers differing in active ingredient and carrier on weight gain and fecal egg count in stocker beef cattle. Jonathon L Beckett*¹, Brian P Wetzell¹, Tim Richards², and Bill Clymer³, ¹*Cal Poly State University, San Luis Obispo*, ²*Kahua Ranch, Ltd, Kamuela, HI*, ³*Fort Dodge Animal Health, Overland Park, KS*.

The objective of the studies was to compare, under field use conditions, the efficacy and persistency of moxidectin (M), ivermectin (I) and doramectin (D) pour-on parasiticides at 500 µg/kg with an untreated control in stocker cattle exposed to naturally acquired nematode infection. The study was conducted over two grazing seasons using single-source crossbred steers and heifers commingled in an intensive grazing situation. During the first year, 100, 100, 99, and 99 cattle (initial weight 146.9kg) were treated on day 0 and retreated on day 70 with M, I, D or CON, respectively. To determine persistency, during the second year, 123, 126, 125, and 125 cattle (initial weight 171.8kg) were treated with M, I, D or CON, respectively, but were not retreated. Weight gains and fecal egg counts (EPG) were determined on 25% of each treatment group each 5-6 weeks. Grazing continued for 105 and 126 days for years 1 and 2, respectively. During year 1, weight gains were 95.3^a, 92.0^b, 94.4^a, and 78.9^c kg for M, I, D and CON treatments, respectively. During year 2, weight gains were 113.7^a, 109.3^b, 110.9^b, and 102.4^c kg for M, I, D and CON treatments, respectively. In both trials, fecal egg counts were significantly higher ($P < .05$) in CON cattle compared with dewormed treatments. No differences in fecal egg counts were consistently detectable between dewormed groups. In summary, with 2 treatments, M and D treatment groups appeared to gain equally while exposed to parasites. Response to ivermectin was poorer than to the other two dewormers ($p < .05$). With only one treatment, moxidectin tended to increase weight gains compared with D or I. CON group demonstrated

significantly reduced weight gains in all cases ($p < .05$). This was true regarding total body weight gain and average daily gain, and is supported by the fecal egg count data. Producers must weigh all of the advantages offered by each of the products including but not limited to efficacy and persistency.

Key Words: Stocker, Cattle, Parasite

W157 Ultrasound and carcass measures of different biological types of beef cattle developed under a rotational management-intensive grazing system. M. L. Thomas*¹, T. L. Perkins², A. H. Brown, Jr.¹, R. T. Baublits¹, D. W. Kellogg¹, and Z. B. Johnson¹, ¹*University of Arkansas*, ²*Southwest Missouri State University, Springfield*.

Yearling beef steers (n=33) representing four biological types, typical of commercial cattle in northwest Arkansas, were evaluated for muscle and fat deposition utilizing real-time ultrasound measurements and carcass traits. Biological types included large framed, late maturing (LL, n=6), medium framed, late maturing (ML, n=9), medium framed, intermediate maturing (MI, n=9) and medium framed, early maturing (ME, n=9) steers. Animal diet consisted of only forages utilizing a rotational management-intensive grazing system in which animals were allocated new paddocks on a daily basis. Target weight and body condition score at harvest were 454 kg and 6.0 (on a 1 to 9 scale), respectively. Average days on trial before harvest were 300 with a mean harvest weight of 462.8 kg and a 5.9 body condition score. Overall mean gain was 222 kg at a 0.74 kg average daily gain. Generally, carcass data were correlated with the final ultrasound readings. Mean marbling score was greater ($P < 0.05$) for ME than LL steers (346 ± 25 vs. 239 ± 27). There was no difference ($P > 0.05$) in mean marbling score for MI and ML steers (285 ± 24 and 253 ± 22). There was an interaction ($P < 0.05$) between biological types and days on grass until harvest for ribeye area. Days on grass did not affect ($P > 0.05$) other carcass traits. Based on marbling scores, ME steers best fit the all-forage diet utilizing a rotational management-intensive grazing system.

Key Words: Ultrasound, Biological Types, Management-Intensive Grazing

W158 Effect of feeding corn silage diets on reduction of drinking water intake and growth performance of cattle in feedlot under hot humid weather in the Northwest of Mexico. R. Barajas*¹, B. J. Cervantes¹, A. Camacho¹, R. J. Virgilio², P. Castro², and E. Sanchez³, ¹*FMVZ - Universidad Autonoma de Sinaloa, Culiacan-Mazatlan, Mexico*, ²*Tecnologia de Maxima Produccion S.A. de C.V., Sector Humaya, Mexico*, ³*UAEGES, Culiacan-Sanlana, Mexico*.

The objective was to determine the effect of feeding corn silage diets on reduction of drinking water intake and growth performance of cattle in feedlot under hot humid weather in the Northwest of Mexico. A 164-d (Jun-Nov/03) feedlot experiment was conducted using 94 Brahman-cross bull calves (BW= 204.8 ± 2.7 kg). Calves were blocked by weight into eight groups for a completely randomized block design. Calves were assigned one or two feeding programs: 1) diets based in ground corn, containing sudan grass hay as roughage during all the feeding period (Control); or 2) diets containing corn silage substituting all sudan grass hay and partially the ground corn. Diets were fed for 126-d and then fed with control diet until the end of experiment (silage). Mean temperature was 28.4° C and precipitation was 651 mm. Silage treatment shown lower ($P = 0.05$) BW during the first 56-d. Ending weight was not affected ($P = 0.36$) by treatments. Average daily gain was lower ($P = 0.01$) for silage in day 28; however from day 57 to 112 ADG was higher ($P = 0.04$) for cattle feed silage diets. ADG throughout the experiment was similar ($P = 0.41$) (1.32 vs. 1.28 kg). DMI was diminished ($P = 0.01$) by silage diets (8.70 vs. 8.31 kg/day). Feed/gain ratio was not affected ($P = 0.67$) by treatments (6.35 vs. 6.23). Silage diets reduced ($P = 0.01$) drinking water intake by 36% during the first 112 days in feedlot (24.3 vs. 16.4 L/day), and 23% ($P = 0.06$) during the entire experiment (23.54 vs. 18.08 L/day). The sum of feed intake (wet basis) plus water intake was similar ($P = 0.66$) in both treatments (34.58 vs. 35.6 kg/day). The amount of drinking water required by kg of gain was diminished ($P = 0.05$) by 25 % in silage diets (16.79 vs. 12.65 L/kg). Carcass weight, dressing, marbling score, KPH fat, color and quality grade were not affected ($P > 0.10$) by treatments. It is concluded that the use of diets containing corn silage, can help to reduce near of 25

% the requirements of drinking water for feedlot cattle, without affect negatively impacting performance or carcass quality.

Key Words: Corn Silage, Drinking Water, Feedlot Cattle

W159 The effect of different types of morphologically abnormal spermatozoa on bovine embryo development after IVF. A. H. Walters*¹, W. E. Eyestone², R. G. Saacke¹, R. E. Pearson¹, and F. C. Gwazdauskas¹, ¹Virginia Polytechnic Institute and State University, Department of Dairy Science, Blacksburg, ²Virginia Polytechnic Institute and State University, Department of Large Animal Clinical Science, Blacksburg.

The study was conducted to evaluate the effect of semen samples collected from bulls subjected to scrotal insulation on embryonic development after in vitro fertilization (IVF). Morphologically abnormal semen samples from four Holstein bulls were cryopreserved following a scrotal insulation period of 48 h (d 0). Three types of semen samples were used for IVF: 1) semen from bulls collected 5 d prior to scrotal insulation (Pre-insult); 2) semen from d 13 (2 wk-PI); and 3) d 20 (3 wk-PI) post-insult. Following an 18 h sperm-oocyte co-incubation, embryos

were cultured for 8 d and evaluated. The post-thawed morphological evaluation of semen revealed a decrease ($P < 0.01$) in the percentages of normal spermatozoa in the post insult samples (3 wk-PI) compared with the Pre-insult samples for Bulls I and Bull III ($74 \pm 2.4\%$ to $22.3 \pm 2.4\%$ and $67.7 \pm 2.4\%$ to $0.5 \pm 2.4\%$, respectively), while the percentage vacuolated spermatozoa increased significantly for Bull II (diadem-0% to $59.6 \pm 2.0\%$; apical vacuoles- $1.06 \pm 3.6\%$ to $47.8 \pm 3.6\%$). There was no change in abnormal sperm population for Bull IV ($<10\%$). The cleavage and blastocyst formation rates and embryo development scores were affected ($P < 0.01$) by the interaction of bull by sample collection time. For Bull I and Bull III (severe responders) there was a decreased rate of cleavage ($77.9 \pm 1.9\%$ to $62.7 \pm 1.7\%$ and $85.5 \pm 1.7\%$ to $66.3 \pm 1.5\%$) and blastocyst formation ($23.4 \pm 1.9\%$ to $10.6 \pm 1.7\%$ and $26.8 \pm 1.7\%$ to $13.5 \pm 1.6\%$) decreased between the Pre-insult and 3 wk-PI samples. In contrast, the cleavage and blastocyst formation rates for Bull II ($71.6 \pm 1.4\%$ and $16.9 \pm 1.5\%$) and Bull IV ($77.8 \pm 1.7\%$ and $21.4 \pm 1.5\%$) were unaffected. In conclusion, a decrease in embryonic development seems to be related to the changes in head shape morphology.

Key Words: Abnormal Spermatozoa,, Scrotal Insult, IVF

Goat Species

W160 Replacement of alfalfa neutral detergent fiber with a combination of nonforage fiber sources on ruminal pH and performance in Alpine goats raised under natural conditions in northern Mexico. P. A. Robles-Trillo*¹, L. Garcia-Palestina¹, E. De Lazaro-Urbina¹, R. Rodriguez-Martinez¹, and R. Bañuelos-Valenzuela², ¹Universidad Autonoma Agraria Antonio Narro Unidad Laguna, Santa-Fe, Torreon, Mexico, ²Unidad Academica de Medicina Veterinaria y Zootecnia, UAZ, Victor Rosales, Mexico.

There has been a limited number of studies carried out on goats about the physiological and productive consequences when NDF is replaced with nonforage fiber sources (NFFS). To evaluate the effect of replacing NDF from alfalfa with NFFS combination (whole linted cottonseed, soy hulls, and wheat bran) on ruminal pH, ADG, dry matter intake (DMI), and feed efficiency (FE), sixteen Alpine goats (body weight of 22.81 ± 1.84 and 7 months old) were used in a 4 x 4 block design. The four diets were basal control diet (LAD) low in forage and fiber (9.27% of alfalfa NDF and 6.72% of corn silage NDF, DM basis), a normal forage diet high in alfalfa (HAD) (LAD diet, plus 14% of alfalfa NDF), and two low forage diets with either 9.4% NDF (LNFD) or 18.18% (HFND) NDF DM basis from the NFFS combination. Ruminal samples were obtained by stomach tube each 3 h by seven times daily to determinate the pH ruminal content by a potentiometer. DMI and FE were calculated by body weight and weight gain daily. The effects of treatments upon pH, ADG, DMI, and FE were evaluated and analyzed by means of ANOVA. Our results showed an effect of treatment ($P < 0.001$) on ruminal pH, which was highest for the HAD treatment and lowest for LAD, without differences between LNFD and HFND. A difference in ADG ($P < 0.05$) was found between LAD and HAD, but values were similar between LNFD and HFND. There were no differences ($P > 0.05$) in DMI. FE was greater ($P < 0.05$) for LAD vs HAD. The replacement of NDF from alfalfa with NFFS did not reduce ruminal pH with respect to the normal forage diet (LAD) and therefore, ruminal function could have remained normal. However, NFFS had a detrimental effect on ADG and FE without affecting DMI, which could be important to economic profitability depending on cost of NFFS products.

Least square means for ruminal pH (pH), average daily gain (ADG), dry matter intake (DMI), and feed efficiency (FE) in goats (N=16) with four different diets (LAD, LNFD, HFND, and HAD) in Northern Mexico (25° NL)

Variables	Treatments				S.E.M.
	LAD	LNFD	HFND	HAD	
pH	6.13 ^a	6.19 ^a	6.26 ^b	6.33 ^c	0.02
ADG	0.089 ^a	0.060 ^{ab}	0.065 ^{ab}	0.043 ^b	0.01
DMI	47.03 ^a	45.21 ^a	46.71 ^a	44.31 ^a	1.62
FE	0.11 ^b	0.08 ^{ab}	0.08 ^{ab}	0.06 ^a	0.01

^{a,b,c}Means within a row with unlike superscriptors are different ($P < 0.05$)

Key Words: NDF, Nonforage Fiber Sources, Goat Performance

W161 Influence of diet and gut fill on blood metabolites and fecal shedding of *E. coli* in sheep and goats. V. R. Gutta*, G. Kannan, B. Kouakou, K. M. Gadiyaram, W. R. Getz, G. W. McCommon, and Y. Lan, Fort Valley State University, GA.

Recent reports have shown that fecal shedding of *Escherichia coli* can be reduced by preharvest management practices in small ruminants. The objectives of this experiment were to determine the effects of diet and feed deprivation time prior to harvesting on fecal *E. coli* shedding and blood metabolite concentrations in sheep and goats. In an RCBD split-plot design, sheep (wethers, n = 16) and goats (bucks, n = 16) were assigned to 8 pens (4 sheep or goats/pen) and fed either a concentrate diet or a hay diet for four days. The animals (8 - 12 mo of age) were then taken to the processing facility and subjected to either 12 or 24 h feed deprivation prior to harvesting, with continuous access to water. Sterile sponges were used to sample (5 x 5 cm area) hind legs of each animal for *E. coli* contamination before and after feed deprivation. Blood samples were also collected to determine urea nitrogen (BUN) and glucose levels prior to harvesting. Generic *E. coli* counts in the rumen were higher ($P < 0.01$) in animals subjected to 24 h feed deprivation than those subjected to 12 h feed deprivation. *E. coli* counts in the rectum were higher ($P < 0.01$) in concentrate-fed than in hay-fed animals. *E. coli* contamination of hair/fleece was higher ($P < 0.05$) in sheep than in goats. Behavioral observations during holding revealed that sheep spent more time lying down than goats, indicating that sheep are more prone for fecal contamination from the pen floor during preharvest holding than goats. The pH values of rumen and colon contents were higher ($P < 0.01$) in hay-fed animals than concentrate-fed animals. Glucose and BUN concentrations were not influenced by diet or feed deprivation. Fecal contamination in sheep and goats can be controlled by preharvest dietary management, with no significant changes in glucose and BUN levels. The results indicate that hay feeding and shorter feed deprivation period decrease *E. coli* counts. Sheep may be more prone for fecal contamination during holding.

Key Words: Sheep and Goats, *E. Coli*, Fecal Contamination

W162 Effect of different levels of food and water deprivation on serum levels of catecholamines, glucose, and creatinine in Mexican-native goats. C Meza, RM Rincon, R Bañuelos, F Echavarria, and CF Arechiga*, *Universidad Autonoma de Zacatecas, Mexico*.

Level of stress by food and water deprivation was evaluated on Mexican native goats by determination of serum catecholamines, glucose, and creatinine. Goats ($n=12$ and weight 29.5 ± 2.0 kg) from north-central Mexico ($23^{\circ} 00'$ latitude N and $102^{\circ} 30'$ longitude W at 2,150 m above sea level), were randomly assigned into 4 groups: FWD 0 = Control, without food and water deprivation (fed daily ad libitum); FWD 1 = food and water deprivation of 1 d (fed every day just for 2 h); FWD 2 = food and water deprivation of 2 d (fed every 2 d just for 2 h); and FWD 3 = food and water deprivation of 3 d (fed every 3 d just for 2 h). The experiment was conducted from November through April (autumn-winter). Every month, during the 4th wk, each goat was bled in order to obtain nine blood samples at different 15-min intervals before and after food and water were given (-45, -30, -15, 0, 15, 30, 45 min). Serum samples of glucose and creatinine were analyzed by spectrophotometry while catecholamines were determined by fluorometric techniques. The average serum concentration was 19.21 mg/dL for catecholamines, 57.22 mg/dL for glucose, and 2.74 mg/dL for creatinine. Food and water deprivation affected serum glucose concentration ($P < 0.05$) without affecting creatinine or catecholamines. In contrast, month of gestation affected ($P < 0.05$) all three variables. In fact, while serum catecholamines levels were intermediate at the beginning of the gestation, they decreased towards the intermediate gestation, and were highest at the end of the gestation. A positive correlation was observed between glucose and creatinine suggesting a possible catabolic scenario in muscular tissue followed by an increased level of hepatic gluconeogenesis. Even though nutritional and hydric stress affected glucose serum levels, this metabolic restriction did not compromise embryonic and fetal development as well as kidding percentage, suggesting a high degree of adaptation of Mexican-native goats to face stress by food and water deprivation.

Key Words: Goats, Catecholamines, Food Scarcity

W163 Effect of buck presence on frequency, amplitude, and concentration of luteinizing hormone (LH) in Mexican-native goats exposed to artificial photoperiod. R. M. Rincon*, C. F. Arechiga¹, F. J. Escobar¹, M. A. Lopez¹, and J. Valencia², ¹*Universidad Autonoma de Zacatecas, Mexico*, ²*Universidad Nacional Autonoma de Mexico*.

The purpose of present work was to evaluate the effect of introducing a sexually-active male buck on LH pulse frequency, amplitude, and concentration in Mexican-native goats exposed to a 6-month long artificial photoperiod. Female goats ($n=30$) were either exposed to the presence or absence of a male buck ($n=15$ /group). Within each group, there were Control (CON, $n=5$), Ovariectomized (OVX, $n=5$), and Ovariectomized + Estradiol-implanted goats (OVX + E2X, $n=5$). All female goats were exposed to a 6-month long artificial photoperiod ranging from 10.6 to 13.4 h of light during the day (short and long days). Blood samples were obtained during short and long days for sampling periods of 6 hours every 15 min. Progesterone and LH levels were determined by RIA. Presence of a male buck increased ovarian activity of native goats. LH frequency, amplitude, and concentration were higher ($P < 0.001$) in response to male buck presence (frequency = 3.13 vs 1.34 pulses/6 h; amplitude = 1.50 vs. 0.96 ng/mL; concentration = 4.61 vs 2.70 ng/mL). Progesterone concentrations were also higher in response to male buck presence (4.04 vs 2.20 ng/mL). Presence of a male buck maintained LH pulse frequency and concentration elevated in goats despite being exposed to an inhibitory photoperiod. In conclusion, male-buck presence influence reproductive activity of Mexican-native goats in north-central Mexico.

Key Words: Goats, Luteinizing Hormone, Photoperiod

W164 Mineral content of diets selected by range criollo goats in a poor condition shrubland of north Mexico. M. A. Cerrillo-Soto*, G. Nevarez-Carrasco, R. Montoya-Escalante, and A. S. Juárez-Reyes, *Universidad Juarez del Estado de Durango, Dgo, Mexico*.

The study was conducted to determine the mineral content in diets selected by goats grazing a poor condition shrubland in a semi-arid region of north Mexico. The study area is located at $24^{\circ} 04'$ N, $103^{\circ} 23'$ W, altitude of 1,435 m, annual mean temperature is 17° C and rainfall is about 278 mm. Six nonlactating female goats (30 ± 4.9 kg BW) fitted with esophageal cannulae were used to collect monthly extrusa samples. The sampling was performed in October, December, January, March, April, May, June, July, and September. Animals were sampled two days each month at 1130 and 1530 for 45 min. The samples were composited, dried, and ground (1 mm). Ca, Mg, K, Na, Co, Cu, Mn, Fe, and Zn determinations were performed by atomic absorption spectrophotometry. Phosphorus was determined by colorimetry. Data were statistically analyzed for a completely randomized design. Macro mineral concentrations of the forage selected by goats varied ($P < 0.05$) among months. Calcium content ranged from 8.2 to 28.8 g/kg (mean = 16.0 g/kg). Content of P ranged from 1.1 to 3.5 g/kg (mean = 2.3). Dietary Mg ranged from 1.7 to 3.3 g/kg (mean = 2.2 g/kg). Potassium content ranged from 9.7 to 21.7 g/kg (mean = 16.1 g/kg). Mean concentration of Na was 3.87 g/kg and varied from 3.4 to 4.3 g/kg. Magnesium concentration ranged from 1.5 to 3.3 g/kg (mean = 2.2 g/kg). Trace minerals concentrations also varied ($P < 0.05$). The Co content varied from 13.2 to 19.4 mg/kg (mean = 14.7 mg/kg). Concerning Cu, concentration ranged from 6.7 to 11.6 mg/kg (mean = 8.4 g/kg). Concentration of Mn ranged from 27.1 to 99.1 mg/kg (mean = 54.2 mg/kg). Zinc concentration ranged from 19.6 to 81.0 mg/kg (mean = 30.4 mg/kg). Iron content varied from 96.1 to 708.2 mg/kg (mean = 350.8 mg/kg). Results suggest that P, Na, Cu, and Zn contents do not satisfy goat requirements; thus, a supplementation program should be implemented.

Key Words: Minerals, Grazing, Goats

W165 Mineral content of forage selected by goats grazing an oak shrubland in north Mexico. M. A. Cerrillo-Soto*, G. Nevarez-Carrasco, R. Montoya-Escalante, and A. S. Juárez-Reyes, *Universidad Juárez del Estado de Durango, Dgo, Mexico*.

A study was conducted to estimate the mineral content of the diet selected by goats grazing an oak shrubland in the central region of Durango, Mexico. The study area is located at the $24^{\circ} 32'$ N and $104^{\circ} 28'$ W at 2340 m. The climate is semi-arid with a mean annual rainfall of 376 mm and temperature of 16° C. Six adult female Spanish criollo goats (35 ± 5 kg BW) were used to obtain samples according to the hand-plucked method. The samples were collected monthly for two days, morning and evening, for a period of twelve months. Mineral concentrations of Ca, Mg, K, Na, Cu, Mn, Fe, and Zn in monthly diets were determined using an atomic absorption spectrophotometer. Phosphorus concentrations were determined by colorimetry. Data were analyzed for a completely randomized design. Macro mineral concentrations of the forage selected by goats varied ($P < 0.05$) among months. Sodium content ranged from 0.17 to 0.33 g/kg with a mean of 0.23 g/kg. Dietary Ca ranged from 4.6 to 17.8 g/kg, with an annual mean of 12.7 g/kg. Phosphorus content ranged from 0.73 to 1.80 g/kg, and the mean was 1.1 g/kg. Annual mean concentration of Mg was 3.1 g/kg and the concentration varied from 1.8 to 4.7 g/kg. Potassium concentration in the forage selected by goats ranged from 8.2 to 16.7 g/kg, with a mean of 12.6 g/kg. Forage concentrations of trace minerals also varied ($P < 0.05$) among months except for Zn. Copper concentration ranged from 4.3 to 9.0 mg/kg (mean = 6.5 g/kg). Concentration of Mn ranged from 69.1 to 276.3 mg/kg (mean = 176.1 mg/kg). Concerning Fe, the concentration ranged from 29.9 to 136.2 mg/kg (mean = 65.8 mg/kg). Finally, Zn content did not differ among months ($P > 0.05$; mean = 59.9 g/kg). Data indicated that contents of Ca, K, and Mg in all months are adequate to meet the requirements of adult range goats for maintenance, pregnancy, and lactation. Moreover, Mn, Zn, and Fe contents also meet the requirements. However, Na, P, and Cu concentrations in the diet are below requirements. Thus, a supplementation schedule for these minerals should be implemented throughout the year to maintain productivity of goats.

Key Words: Minerals, Goats, Grazing

W166 Silymarin administration to transition dairy goats: effects on liver tissue and plasma metabolites. D. Tedesco^{*1}, S. Galletti¹, D. Olivero², M. Tameni¹, and S. Rossetti¹, ¹Department of Veterinary Sciences and Technologies for Food Safety, Milan, Italy, ²BiEsseA, Milan, Italy.

The fatty liver syndrome frequently develops in dairy cows in the transition period between late pregnancy and early lactation. Little is known about this condition in dairy goats. Silymarin, a standardized extract from seeds of *Silybum marianum* L. (Gaertn) (milk thistle), is used in human for the treatment of liver diseases of different aetiologies. The aim of the present study was to determine the silymarin effects on liver tissue and haematic parameters of lipid metabolism in transition dairy goats. A total of 24 dairy goats in their second pregnancy were divided into two groups according to body condition score (BCS), health condition, and previous milk production. From 5 d prior to the expected kidding date to 15 d postpartum, the treated goats received 10 mL/d of silymarin as a water suspension, administered as oral drenches. Blood samples were collected from the jugular vein at -5, 0, and 14 d from kidding. Non-esterified fatty acids (NEFA) and β -hydroxybutyrate (BHBA) concentrations in plasma were measured. Liver biopsies were performed 7 d after parturition and liver samples were immediately frozen at -196°C in liquid nitrogen. Samples were sectioned at 3 μ with a cryostat. The sections were then stained with haematoxylin-eosin and osmium tetroxide. This specific method indicates lipid accumulation. Plasma concentrations of NEFA and BHBA were unaffected by treatment. Histological examinations showed fat accumulation in livers of control goats. This accumulation is black stained with the special method used. No fat accumulation was observed in silymarin treated goats. We conclude that treatment with silymarin extract in the peripartum period completely prevented fat accumulation in dairy goats. Silymarin was kindly granted by Indena S.p.A.

Key Words: Silymarin, Dairy Goats, Liver Tissue

W167 Assay of antibiotic residues in goat milk. M. Bsharat* and R. Attaie, *Prairie View A&M University, TX.*

Ten milking goats, 5 Nubians and 5 Alpines, were randomly selected from the milking herd of the International Goat Research Center at Prairie View A&M University. The objective was to determine the residual amounts of tetracycline in the milk of treated goats. It was essential to determine the safe withdrawal period of tetracycline in goat milk using screening tests such as the Charm ROSA Tetracycline and the SNAP Tetracycline tests. The results of these screening tests were compared with a quantitative procedure that was developed for determination of tetracycline residues in milk using a HPLC technique. Milk samples containing antibiotic residues were deproteinized by HCl and acetonitrile and then extracted. The concentrated extracts were filtered before injection into reversed-phase HPLC using an isocratic procedure. For analysis, a Wakosil II C18 column was used with a mobile phase of 0.02 M H₃PO₄ and 0.01 M Na decansulfonate-acetonitrile (65+35) using UV detection at 380 nm. The Charm Rosa test was able to detect the residues up to 96 hours after administration of drug and then gave doubtful results. The SNAP Tetracycline test was able to detect the residues up to 110 hours after injection, showing higher sensitivity. However, the HPLC procedure determined the tetracycline residues in goat milk at levels less than the tolerance limit of 300 ppb after 72 hours of drug administration.

Key Words: Goat Milk, Antibiotic, Residues

W168 Evaluation of Mimosa (*Albizia julibrissin*) and Leucaena (*Leucaena leucocephala*) as feeds for goats. J. Q. Bing* and R. N. Corley III, *Tuskegee University, AL.*

A study was conducted to determine the potential of mimosa (*Albizia julibrissin*) and leucaena (*Leucaena leucocephala*) as feeds for goats. Mimosa and leucaena were harvested in Tuskegee, Alabama in the fall of 2003 and compared with alfalfa hay. Proximate analysis and measurements of NDF, ADF, Ca, K, and Mg were determined. Three non-lactating Nubian female goats fitted with permanent ruminal cannulas were used in a randomized complete block design to determine the kinetics of ruminal digestion. For alfalfa hay, mimosa, and leucaena, respectively, values for dry matter (92.65, 96.88, and 97.42%), crude protein (24.38, 13.31, and 17.81%), NDF (29.00, 53.00, and 36.00%), ADF (24.00, 37.00, and 29.00%), Ca (1.73, 0.62, and 0.80%), K (1.99,

0.85, and 1.20%), and Mg (0.30, 0.26, and 0.35%) were comparable. Ruminal digestion kinetics of alfalfa hay, mimosa, and leucaena, respectively, estimated that 34, 26, and 24% was soluble, 46, 55, and 29% was potentially degradable, 20, 19, and 47% was indigestible, and that the fractional rate of digestion was 0.10, 0.07 and 0.03h⁻¹. Alfalfa hay had a higher (P<0.05) soluble fraction than mimosa or leucaena, which did not differ (P>0.05) from each other. Mimosa had a larger (P<0.05) degradable fraction than alfalfa hay, which was more digestible (P<0.05) than leucaena. Mimosa and alfalfa hay, which did not differ (P>0.05), had lower (P<0.05) indigestible fractions than leucaena. Alfalfa hay had the highest (P<0.05) fractional rate of digestion, followed by mimosa, which was higher (P<0.05) than leucaena. As a whole, chemical composition and digestibility characteristics of mimosa appeared comparable to alfalfa hay, which shows its potential as a feed for goats. Further study is needed to determine the effects of mimosa on ruminal fermentation and animal performance.

Key Words: Leucaena (*Leucaena Leucocephala*), Mimosa (*Albizia Julibrissin*), Goats

W169 Evaluation of *Albizia julibrissin* (mimosa) for internal parasite control in goats. C. Hopkins-Shoemaker*¹, S. Solaiman², B. Blagburn¹, D. Bransby¹, and C. Kerth¹, ¹Auburn University, AL, ²Tuskegee University, AL.

Anecdotal information in the literature suggests that *Albizia julibrissin* (mimosa) may have anthelmintic properties, and parasite control is a major management concern in the southeastern U.S., especially for goats. This experiment was conducted to determine the effect of mimosa fed to goats, with experimentally induced *Haemonchus contortus* larvae, on parasite burden and selected blood parameters. Eighteen Boer cross goat kids (BW \pm 0.07 kg) were housed in individual pens and randomly assigned to two dietary treatments: 1) 90% fresh cut mimosa with 10% alfalfa hay (MA), as fed, and 2) a control treatment of 85% green chop soybeans with 15% of bermudagrass hay (SB), as fed. Dietary treatments were calculated to be isonitrogenous on a DM basis. Feed intake and refusals were monitored daily and feed offered was adjusted weekly for 4 wk. Body weight was recorded weekly after a 4 h withdrawal from water and feed. Fresh feces were collected from each goat weekly and fecal egg counts were conducted using a modified McMaster method. Blood samples were collected weekly, via the jugular vein, and were analyzed for pack cell volume and plasma protein. Dry matter intake was higher (P < 0.01) for animals fed MA (344 and 305 g/d, SE \pm 11, for MA and SB, respectively). Total egg count did not drop based on Kruskal-Wallis and Mann-Whitney tests during the 4 wk experimental period. Initial fecal egg counts were 5,522 \pm 2,317 and 4,555 \pm 1,385, and final egg counts were 8,878 \pm 3,155 and 8,800 \pm 1,234, for treatment groups MA and SB, respectively. Pack cell volume and plasma protein showed no difference (P > 0.10) between dietary treatments or over time. These results indicated that short-term treatment of goats with mimosa was not effective in eliminating or managing *Haemonchus contortus* under controlled feeding conditions. However, long term feeding of mimosa under field conditions may have benefits as a parasite management tool because it allows the animal to browse rather than graze.

Key Words: Mimosa, Parasites, Goat Kids

W170 The use of crawfish meal waste as a protein source for feeding goats. S. Gebrelul*, C. R. Walker, A. Harris, and A. Dantzler, *Southern University and A&M College, Baton Rouge, LA.*

The cost of feed, especially protein sources, represents the single greatest expense (65-80%) of livestock operations. One alternative protein source for goats is crawfish meal as a substitute for soybean meal. In Louisiana, approximately 15 million tons of crawfish are consumed annually. Only 15 percent of the crawfish is edible and the rest is waste. The purpose of this study was to evaluate the growth performance of weaned kids fed crawfish meal. In a completely randomized design, 20 kids were randomly assigned to four treatment groups. The first group served as a control and was fed a concentrate ration that contained 75% corn, 20% soybean meal, and 5% molasses. Fifty, 75, and 100 percent of the protein source (soybean meal) in the control ration was substituted by crawfish meal for the second, third, and fourth groups, respectively. After an adjustment period of two weeks, kids remained in the experiment for six weeks. Initial and final weights, weekly weights, and group

feed consumption were recorded. Data were analyzed by ANOVA where feeding treatment was fitted as main effect. The average weights at the end of the sixth week for the four groups were, respectively, 15.9, 16.2, 16.7, and 13.8 kg ($P > 0.05$). Feed consumption per week averaged 5.6, 3.5, 3.5, and 2.3 kg. Kids in the control and 50% substitution treatment groups grew faster (62.8 and 41.1 g/day, respectively; $P < 0.05$) than kids in the 75 and 100% substitution groups (17.3 and 8.7 g/day, respectively). From these preliminary data, soybean meal in goat rations can be substituted by crawfish meal up to 50 percent. More detailed studies with more animal numbers are needed to determine the effects of crawfish meal as a true protein substitute in goat rations as well as the quality and acceptability of carcasses produced from goats fed crawfish meal.

Key Words: Crawfish Meal, Goats, Soybean Meal

W171 Evaluation of three novel anthelmintics to control internal parasites in female Boer goats. R. Franco*¹, M. Worku¹, J. Miller², D. Libby¹, T. Hanner¹, and P. Matterson¹, ¹North Carolina Agricultural and Technical State University, Greensboro, ²Louisiana State University, Baton Rouge.

The effect of neem (*Azadirachta indica*), wormwood (*Artemisia absinthium*), and tobacco (*Nicotiana tabacum*)+copper sulfate (CuSO_4) or no treatment on packed cell volume (PCV), body weight (BW), fecal egg count (FEC), total white blood cell counts (TWBCC), and white blood cell differential counts (WBCDC) were studied in goats infected with internal parasites. Twenty female Boer goats weighing approximately 40 kg were randomly assigned to four treatments (5 animals each). Goats were drenched with 250 ml of a crude water extract adjusted for protein concentration. Differences were observed between BW of the control group (38.2 kg) and that of the tobacco+ CuSO_4 group (42.9 kg) ($P \leq 0.019$). The control group had a higher PCV (25.5%) compared to neem (21.7%), wormwood (19.4%), and tobacco+ CuSO_4 treatments (20.4%) ($P \leq 0.002$). TWBCC and FEC analysis showed no differences between any of the treatments ($P \leq 0.941$ and $P \leq 0.832$ respectively). Neem treatment significantly reduced the percentage of neutrophils compared to control and wormwood ($P \leq 0.017$). The lymphocyte count was lower for the wormwood treatment (41.2%) compared to the control (52.43%), neem (51.15%), and tobacco+ CuSO_4 treatments (49.35%) ($P \leq 0.012$). BW was positively correlated with monocyte counts ($r = 0.616$, $P \leq 0.0189$) only. PCV had a negative correlation with FEC ($r = -0.744$, $P \leq 0.0023$), TWBC ($r = -0.769$, $P \leq 0.0013$), and eosinophil counts ($r = -0.736$, $P \leq 0.0026$). High FEC, TWBCC, and eosinophil counts were observed when low PCV values were recorded. FEC correlated positively with eosinophil counts ($r = 0.575$, $P \leq 0.031$). TWBCC correlated positively with monocyte counts ($r = 0.581$, $P \leq 0.029$) and eosinophil counts ($r = 0.599$, $P \leq 0.023$). These correlations existed even though none of the variables were significantly different among treatments. Neutrophil and lymphocyte counts were negatively correlated ($r = -0.92$, $P \leq 0.0001$). A progressive decline in the percentage of neutrophils was observed following neem treatment.

Key Words: Anthelmintics, Goats, Neem

W172 Evaluation of diatomaceous earth as a component of goat production practices. C. Bernard*, M. Worku, P. Matterson, D. Libby, T. Hanner, and M. Ahmedna, North Carolina Agricultural and Technical State University, Greensboro.

Diatomaceous Earth (DE) is a natural insecticide that has been promoted as an alternative anthelmintic with potential production advantages. This study evaluated the effectiveness of DE in goat production. Twenty-two naturally infected South African Boer, Spanish, and Spanish/Boer crosses were grouped by weight and parasite burden. Animals were drenched with 150 mL of distilled water containing 3.54 (Group 1), 5.31 (Group 2), 1.77 (Group 3), or 0 g of DE (untreated control). Observations were made over 6 wk. Fecal egg counts (FEC) were conducted using the modified McMasters' technique. Packed cell volume (PCV) and white (WBC) and red blood cell (RBC) counts and weights were recorded. Data were analyzed using SAS. Highly significant differences ($P < 0.0001$) in PCV, FEC, and weekly WBC and RBC counts and weights were observed between treated and control groups. Group 1 had an increase in FEC during the experiment of 2,230 eggs/g (63%); Groups 2, 3, and 4 had increases of 1,852 (32%), 3,199 (64%), and 1,833 eggs/g (70.1%), respectively. Each group demonstrated significant increases in PCV during the experiment except for untreated controls

(Group 1: 25.2 to 28.0%; Group 2: 22.6 to 25.8%; Group 3: 21.4 to 22.5%; control: 27.9 to 24.5%). Group 2 produced the largest increase in PCV compared with the pretreatment level. Week of the experiment had a highly significant ($P < 0.0001$) effect on RBC and WBC counts. Each group exhibited increases in WBC and decreases in RBC counts over the course of the study. Change in BW during the experiment differed among treatments ($P < 0.0001$; -0.44, +0.30, -11.60, and -0.79 kg for Groups 1, 2, 3, and 4, respectively). In summary, an anthelmintic effect of DE was not observed; however, a dose dependent improvement in PCV was noted.

Key Words: Goat, Alternative Therapy, Production

W173 Effect of two levels of energy supplementation on forage intake, growth, and blood parameters in Boer and Kiko-sired crossbred kids. S. Wildeus¹, K. E. Turner*², and J. R. Collins¹, ¹Virginia State University, Petersburg, ²USDA, ARS, AFSRC, Beaver, WV.

Feed intake, growth, live grade, and blood metabolites were measured in 32 Boer (B) and Kiko (K)-sired intact male kids from Spanish (S) and Myotonic (M) dams, offered tall fescue (*Festuca arundinacea* Schreb.) hay (13.5% CP, 56.1% NDF, 37.9% ADF, 45.2% IVOMD) and supplemented with a corn (*Zea mays* L.)-based concentrate (16% CP) at either 2 or 3% BW. Kids were allocated to 6 pens (3 pens/supplement level) stratified by breed type and fed for 98 d. Total DMI by pen was lower for 2 than for 3% supplementation in the beginning of the trial (4.21 vs 3.55% BW), but decreased and was not different between groups in middle and end of the trial (treatment \times time on trial; $P < 0.01$). Forage DMI was greater ($P < 0.001$) for 2 than for 3% supplementation throughout the experiment (1.46 vs. 0.79% BW) and was reduced ($P < 0.001$) in both groups in the middle and end of the trial. ADG and final BW were lower ($P < 0.001$) at 2% (101 g/d; 25.0 kg) than 3% (137 g/d; 28.4 kg) supplementation, but not affected by sire or dam breed. Kids supplemented at 2% BW had higher ($P < 0.01$) blood concentrations (mg/dl) of urea nitrogen (21.3 vs 19.3) and lower ($P < 0.001$) glucose (63.1 vs 72.1) compared to those supplemented at 3% BW; creatinine was similar. Supplement level had no effect on live grade, but B-sired kids scored higher ($P < 0.05$) than K-sired kids, and kids from M scored higher ($P < 0.05$) than kids from S. B-sired kids had higher ($P < 0.001$) blood concentrations of urea nitrogen (21.7 vs 19) and creatinine (0.63 vs 0.57) and lower ($P < 0.01$) glucose (65.9 vs 69.2) compared to K-sired kids. Kids from M dams had higher ($P < 0.05$) blood creatinine levels than kids from S dams. Data suggest that sire breed impacted live grade and blood metabolites. Animals receiving the 3% level of supplementation grew faster, but incomplete consumption towards the end of the trial would suggest that a maximum level of energy supplementation for finishing goats was between 2 and 3% BW.

Key Words: Crossbred Goats, Forage Intake, Growth

W174 Effects of the number of yearling Boer crossbred wethers per automated feeding system on feed intake, feeding behavior, and growth performance. A. L. Goetsch*, T. A. Gipson, G. Detweiler, R. C. Merkel, and T. Sahl, *E (Kika) de la Garza American Institute for Goat Research, Langston University, Langston, OK.*

Thirty-six growing Boer \times Spanish wethers (initial BW = 30 ± 0.7 kg) were used in an 82-d experiment to determine effects of the number of animals per automated feeding system (NPF; 6, 8, 10, and 12), allowing consumption by only one animal at a given time, on intake of a pelleted 50% concentrate diet (60% TDN, DM basis), feeding behavior, and growth performance. During the entire experiment DMI (1436, 1506, 1506, and 1312 g/d), ADG (156, 167, 181, and 136 g/d), and ADG:DMI (108, 111, 120, and 103 g/kg for 6, 8, 10, and 12 NPF, respectively) were affected by NPF quadratically ($P < 0.05$, 0.05, and 0.06, respectively). The number of feeder visits (17.5, 17.2, 18.0, and 18.6) was similar among NPF, although feeder occupancy per day (97.8, 73.0, 83.3, and 70.7 min) and visit (5.69, 4.34, 4.84, and 3.79 min for 6, 8, 10, and 12 NPF, respectively) decreased linearly with increasing NPF ($P < 0.05$). The rate of DM consumption relative to feeder occupancy time tended to increase linearly ($P < 0.08$) with increasing NPF because of a relatively low value for 6 NPF (14.9, 21.2, 18.9, and 21.1 g/min for 6, 8, 10, and 12 NPF, respectively). In summary, 8 and 10 growing Boer crossbred wethers per automated feeder, allowing consumption of a 50% concentrate diet by one wether at a given time, resulted in growth

performance greater than for 12 wethers, apparently due to limited feed intake by 12 wethers. Also, performance with 6 wethers per feeder was slightly less than with 8 or 10, which may have involved factors such as limited feed intake resulting from conditions other than inadequate feeder availability.

Key Words: Goats, Feed Intake, Growth

W175 Influence of progesterone on synchronization and pregnancy rate of Alpine does. M. L. Looper^{*1}, R. C. Merkel², E. R. Loetz², A. L. Goetsch², L. J. Dawson³, J. M. Burke¹, and R. Flores⁴, ¹USDA-ARS, Dale Bumpers Small Farms Research Center, Booneville, AR, ²E (Kika) de la Garza American Institute for Goat Research, Langston University, OK, ³College of Veterinary Medicine, Oklahoma State University, Stillwater, ⁴University of Arkansas, Fayetteville, AR.

Forty-one non-lactating Alpine does were used in December to evaluate the effects of progesterone on synchronization and pregnancy rate. Body weight and condition score (1 to 5; 1 = extremely thin) averaged 49.1 ± 1.2 kg and 2.85 ± 0.05, respectively. Prior to the experiment, visual observation detected 95% of does exhibiting behavioral estrus. Does were blocked by age (mean age = 3.2 ± 0.3 y) and assigned to receive progesterone (P4) via an intravaginal insert (CIDR) for 12 d (n = 24) or no P4 (n = 17). Does with a CIDR were administered prostaglandin F2_α 15 h prior to CIDR removal. All does were fitted with a HeatWatch (HW) transmitter to record estrous activity and exposed to intact or epididymectomized bucks (1 buck/5 does) with marking harnesses. Does were observed twice daily (0700 and 1700; 20 min/observation) to confirm behavioral estrus. Ultrasonography was performed to determine pregnancy (mean = 56.6 ± 1.9 d post-breeding). Visual observation verified that 50% of does exhibited behavioral estrus within 24 h after CIDR removal, and 93% of does within 48 h. HeatWatch detected 50% of estruses identified by visual observation. Pregnancy rate was not different (P = 0.46) in does receiving P4 (41%) or no P4 (53%). A majority (93%) of does exposed to progesterone via a CIDR for 12 d exhibited estrus within 48 h post-CIDR removal. Furthermore, visual observation was more accurate at detecting does in estrus than HW. Pregnancy rates were not influenced by progesterone exposure.

Key Words: Goats, Progesterone, Synchronization

W176 Effect of breed and litter size on yields of milk, milk fat, and milk protein in Boer x Spanish and Spanish does. B. Tamir, R. C. Merkel^{*}, T. A. Gipson, and A. L. Goetsch, E (Kika) de la Garza American Institute for Goat Research, Langston University, OK.

Forty-four pregnant does (22 Boer x Spanish (BS), 3 to 4 yr of age; 22 Spanish (SP), 3 to 5 yr of age) were used to evaluate effects of breed and litter size on total milk yield and yields of fat and protein. All does were housed in one pasture and had unlimited access to prairie hay (1.1% N, 66.5% NDF, 63% IVDMD), water, and trace mineralized salt. Seventeen does (9 BS and 8 SP) had single kid (SK) litters and the remaining 27 does (13 BS and 14 SP) had litters of two or three kids (MK). Prior to milking, does and kids were separated at 1600 and weighed. Milking occurred at 0900 the following morning, after which kids were reunited with does. Does were milked once every 2 wk through wk 12 of lactation in a 10-stanchion, automated milking parlor (WestfaliaSurge Inc., Naperville, IL) with an automatic milk sampler. Oxytocin (0.5 ml) was administered 5 min prior to milking to stimulate milk letdown. Milk samples were placed in vials with a preservative and analyzed for fat and protein using a DairyLab II milk analyzer (Mulitspec Ltd., Wheldrake, York, England). Individual total milk, fat, and protein yields were calculated from test day data using Shook adjustment factors. Data were then analyzed using analysis of variance with genotype, litter size, and the two-way interaction as independent variables. Total milk (50.1 vs 37.9 kg; SE = 4.2) and milk protein yields (1.7 vs 1.2 kg; SE = 0.16) were greater for BS vs SP (P < 0.06). In addition, total milk (49.1 vs 38.9 kg; SE = 3.65) and milk protein yields (1.7 vs 1.2 kg; SE = 0.14) were greater (P < 0.07) for MK than for SK does. No differences were seen in ADG of BS vs SP kids (73 and 65 g/d for B and BS, respectively; SE = 5.8) or between female and male kids. Kids of SK does had ADG greater than of MK (86.0 vs 52.5 g/d SE 4.4). Litter growth was similar between BS and SP does. In conclusion, BS does produced more milk

than did SP does, although this was not accompanied by greater kid ADG.

Key Words: Goats, Milk Yield, Breed

W177 Evaluation of predictions of body weight and feed intake by growing crossbred Boer goats with a goat simulation model. M. Villalquiran^{*1}, L. C. Nuty², T. A. Gipson¹, A. L. Goetsch¹, and H. D. Blackburn³, ¹E (Kika) de la Garza American Institute for Goat Research, Langston University, OK, ²Cooperative Agricultural Research Center, Prairie View A&M University, Prairie View, TX, ³USDA/ARS/NPA/NSSL/NAGP, Fort Collins, CO.

The Texas A&M Goat Simulation Model, with modifications such as of maintenance energy requirements, is being used in a collaborative project involving institutions primarily in the southern US. However, the model was developed before Boer goats and their crossbreds became prevalent in the US. Therefore, this study was conducted to evaluate model predictions of BW and cumulative feed intake (air-dry; FI) of growing crossbred Boer goats. Data for model evaluation were derived from Prairie View A&M University. There were four genotypes of wethers: Boer x Nubian (n = 10, age = 131.8 to 245.8 d, and BW = 32.14 to 48.27 kg), Spanish x Boer (n = 8, age = 111.4 to 231.4 d, and BW = 13.73 to 38.27 kg), Boer x Alpine (n = 10, age = 132.4 to 245.4 kg, and BW = 21.86 to 41.77 kg), and Boer x Nubian x Myotonic (n = 10, age = 115.0 to 235.1 d, and BW = 24.00 to 43.05 kg). Diet composition was 16% CP and 75% TDN (air-dry basis). Body weight and FI were determined at four times within the growing periods. Model evaluation with pooled data was conducted by regressing observed means of BW (BWO) and FI (FIO) against predicted values (BWP and FIP, respectively). The equation for BW was BWO = 3.73 (SE = 3.489) + (0.935 (SE = 0.0970) x BWP) (R² = 0.86), and that for FI was FIO = -6.84 (SE = 8.062) + (1.012 (SE = 0.0665) x FIP) (R² = 0.94). In conclusion, the model explained considerable variation in BW and FI of growing crossbred Boer goats and provided unbiased predictions. Increased prediction accuracy should result from improved inputs, such as mature BW.

Key Words: Goats, Simulation Model

W178 Goats for vegetation management: animal performance and carrying capacity. S. Hart^{*}, J. Joseph, and A. Goetsch, E (Kika) de la Garza American Institute for Goat Research, Langston University, Langston, OK.

The objective of this study was to measure factors that affect carrying capacity and animal performance of goats grazing diverse range sites to develop recommendations for stocking rates and expected animal performance. This study was the first year of a larger study on the use of goats for vegetation management, which was conducted in collaboration with six Native American Nations in Oklahoma with a variety of vegetation and range site capabilities. Yearling goats were taken to each site in May-June and weighed every 1 to 2 months. There were at least two pastures at each site. Animals were removed when forage availability became limiting, usually late summer or fall. Goats were heavily stocked to provide maximum vegetation control. Doeling and wether Alpine, Angora, Spanish, and Boer x Spanish cross goats were used. Average daily gain varied with site (P < 0.001), month of the grazing (P < 0.001), breed (P < 0.001), and sex (P < 0.001). Wethers gained more than does (3.3 vs -4.1 g/d). Alpine and Angora goats gained less weight than meat breeds and crossbreds. Goats gained the most weight the first grazing period and less weight subsequently as forage availability was reduced (12.7 vs -9.3 vs -13.6 g/d). Gain per hectare was not influenced by site or stocking rate (P > 0.10), whereas grazing days/ha were different (P < 0.001) for the different sites (P < 0.001; range 237-1,109 d) due to different forage productivities. Gain/ha had little relationship to stocking rate (P > 0.30), a consequence of grazing to remove all available herbage. Total gain for the season was most affected by site (P < 0.001), sex (P < 0.001), and breed (P < 0.001). When goats are grazed at a high stocking density to control vegetation, forage productivity is the greatest factor in determining carrying capacity and animal production although sex and breed can have effect.

Key Words: Goats, Vegetation Management, Stocking Rate

W179 Effects of feed restriction on heat production by mature meat goats. I. Tovar-Luna*, A. L. Goetsch, R. Puchala, and T. Sahu, *E (Kika) de la Garza American Institute for Goat Research, Langston University, OK.*

Fourteen Boer (75%) x Spanish wether goats (51 ± 1.8 kg BW and 23 mo of age) were used to determine effects of a moderate degree of nutrient restriction on heat production (HP). The experiment consisted of a 26-d period (P1) followed by one of 46 d (P2). Wethers were fasted on the final 4 d of each period, with gas exchange measured on the last 2 d. Fasting was preceded by collection of feces and urine for 7 d, with the final 2 d for gas exchange. All wethers were fed a 60% concentrate diet at a level of intake near maintenance in P1 (P1-100 and P1-80 treatments). In P2, six wethers continued on this level of intake (P2-100 treatment); to mimic procedures in a separate experiment, eight wethers also continued at this level for 15 d but then had ME intake sequentially reduced by 10 and 20% for 10 and 21 d, respectively (P2-80 treatment). Dietary ME concentration in period 2 was greater ($P < 0.05$) for 80 than for 100 treatments (13.2 vs 12.4 MJ/kg DM). Intake of ME was lowest ($P < 0.05$) for P2-80 (529, 535, 552 and 474 kJ/kg BW^{0.75} (fasted) for P1-100, P1-80, P2-100, and P2-80, respectively). Fed HP was lowest ($P < 0.05$) for P2-80 (495, 505, 467, and 406 kJ/kg BW^{0.75}), whereas that while fasting was similar among treatments (287, 279, 273, and 253 kJ/kg BW^{0.75} for P1-100, P1-80, P2-100, and P2-80, respectively). The ME requirement for maintenance (ME_m) was greater ($P < 0.05$) in P1 than P2 (477, 487, 421, and 376 kJ/kg BW^{0.75}), and when analyzed for P2 separately ME_m was lower ($P < 0.10$; 374 vs 425 kJ/kg BW^{0.75}) and the efficiency of ME use for maintenance was greater ($P < 0.08$) for P2-80 than for P2-100 (0.689 vs 0.625). In conclusion, moderate feed intake restriction impacted HP by mature meat goats largely via decreasing that associated with or responsive to nutrient intake or workload rather than physiological processes responsible for fasting HP, with a magnitude of change in ME_m 65% of that in ME intake. Supported by USDA Project No. 00-38814-9500.

Key Words: Goats, Energy, Feed Intake

W180 Effects of length of pasture access on energy use by growing meat goats. T. Berhan, R. Puchala*, R. C. Merkel, T. A. Gipson, G. Animut, A. L. Goetsch, and T. Sahu, *E (Kika) de la Garza American Institute for Goat Research, Langston University, OK.*

Six Boer x Spanish wethers (21 ± 1.0 kg BW) were used in two simultaneous 3 x 3 Latin squares to determine effects of different lengths of access to pasture with high availability of cool-season annual forage on energy expenditure (EE), retained energy (RE), ME intake, and grazing behavior. Wethers grazed a 0.7-ha pasture of wheat and rye in the fall/winter period for 4 (1200 to 1600), 8 (0800 to 1600), or 24 h; 4- and 8-h wethers were barn confined at other times. Periods were at least 18 d in length, with 4 d for total feces collection with bags, 2 d to measure heart rate (HR) and grazing behavior, and 1 d without feed or water for assessing body composition from urea space. EE was based on HR and the predetermined relationship between EE and HR for each wether, and ME intake was the sum of EE and RE. Available forage mass averaged 2,831, 2,176, and 2,443 kg/ha in period 1, 2, and 3, respectively. EE was greatest ($P < 0.05$) for 24 h (4.96, 5.13, and 6.19 MJ/d for 4, 8, and 24 h, respectively), although RE was similar among treatments (0.88, 2.16, and 1.57 MJ/d for 4, 8, and 24 h, respectively; SE = 0.361). Intake of ME was greater for 8 and 24 h vs 4 (5.84, 7.30, and 7.76 MJ/d for 4, 8, and 24 h, respectively). Gain of fat (15.7, 50.3, and 33.7 g/d for 4, 8, and 24 h, respectively; SE = 9.80) was responsible for numerically

greatest RE for 8 h, with similar gain of water, protein, and ash. As length of pasture access increased, number of steps (2,508, 4,569, and 6,412), time spent ruminating (4.42, 6.33, and 7.28 h), and time eating (3.77, 6.35, and 7.24 h for 4, 8, and 24 h, respectively) increased ($P < 0.05$). In summary, even though 4-h pasture access limited ME intake and eating time, EE was similar to that for 8 h. Full-day pasture access resulted in greater EE than for 8 h presumably because of differences in behaviors such as eating time and number of steps, yet ME intake was not different. In conclusion, these results suggest that with high availability of high-quality forage, limited pasture access of a minimal length could yield performance by growing meat goats at least comparable to that with continuous access. Supported by USDA Project No. 00-38814-9500.

Key Words: Goats, Grazing, Energy

W181 Effects of pasture inclusion of mimosa on growth by co-grazing goats and sheep. G. Animut*^{1,2}, A. L. Goetsch¹, G. E. Aiken³, R. Puchala¹, G. Detweiler¹, C. R. Krehbiel², R. C. Merkel¹, T. Sahu¹, L. J. Dawson⁴, and Z. B. Johnson⁵, ¹*E (Kika) de la Garza American Institute for Goat Research, Langston University, OK*, ²*Animal Science Department, Oklahoma State University, Stillwater*, ³*USDA ARS Dale Bumpers Small Farms Research Center, Booneville, AR*, ⁴*College of Veterinary Medicine, Oklahoma State University, Stillwater*, ⁵*Department of Animal Science, University of Arkansas, Fayetteville.*

Effects of mimosa alley-cropped in grass/forb pastures on growth performance of co-grazing sheep and goat wethers were determined. Three sheep (Khatadin) and three goats (#8805 75% Boer), with initial BW of 22 ± 1.3 and 21 ± 0.7 kg, respectively, and age of 4 to 5 mo, grazed 0.4-ha pastures of grasses such as bermudagrass and johnsongrass and forbs (e.g., ragweed) for 16 wk. Three pastures with mimosa (3.1 m between rows and 0.46-m interval) and three without (W and WO, respectively) were divided into four paddocks for 2-wk rotational grazing. The number of mimosa trees per pasture averaged 928 and 904 at the beginning and end of the experiment, respectively. Daily mimosa leaf DM removal averaged 25.5 g per animal, although harvest was complete before the end of 2-wk grazing periods. Mimosa leaf samples averaged 2.81, 37.8, and 85.9% N, NDF, and IVDMD (true), respectively. Available forage (grass and forbs) mass was similar ($P > 0.05$) between treatments before (2,928 and 2,695 kg/ha; SE = 183.4) and after grazing (1,507 and 1,452 kg/ha for WO and W, respectively; SE = 140.4). Percentage of grass in forage determined by transect pre- (57.5 and 69.9%; SE = 8.34) and post-grazing (66.3 and 78.8% for WO and W, respectively; SE = 8.09) was not affected by treatment ($P > 0.05$). Pre-grazed forage concentrations of N (1.25 and 1.24%), NDF (64.5 and 63.8%), and IVDMD (52.9 and 56.2% for WO and W, respectively) were similar ($P > 0.05$) between treatments, as was also true post-grazing (N: 1.05 and 0.96%; NDF: 66.3 and 69.4%; and IVDMD: 49.0 and 48.0% for WO and W, respectively). ADG in the first (125 and 119 g/d; SE = 13.0), second (87 and 108; SE = 26.9), third (16 and 44 g/d; SE = 14.6), and fourth 4-wk period (-23 and 0; SE = 27.6) and in wk 1-16 (51 and 68 g/d for WO and W, respectively; SE = 8.6) was similar ($P > 0.05$) between WO and W. In summary, mimosa increased high-quality herbage available for grazing (mimosa leaf) but did not significantly influence growth performance of co-grazing sheep or goats, perhaps because of decreasing availability as 2-wk grazing periods advanced and/or relatively low intake of mimosa leaf. Supported by USDA Project No. 00-38814-9502.

Key Words: Goats, Mimosa, Co-Grazing

Animal Behavior & Well Being

W182 A computerized system for monitoring feeding behavior and individual feed intake of dairy cattle in loose-house conditions. A. Bach*^{1,2}, C. Iglesias², and I. Busto³, ¹*ICREA, Barcelona, Spain*, ²*IRTA-Unitat de Remugants, Barcelona, Spain*, ³*Diputació de Girona, Semega, Girona, Spain.*

The objective of this study was to develop and validate a computerized system to monitor feeding behavior and feed intake of loose-housed dairy cattle. The system consisted of 28 scales located in front of each self-locking place of a regular feed bunk. All cows had access to all scales indifferently. Each visit to the feed bunk was monitored by a transponder in the ear of each cow that was detected by a proximity

reader located at the top right corner of each head-lock. The data from the scales and the proximity readers were continuously recorded by a computer with an average scanning time of 3.5 s. The monitoring system was validated using all 28 feeding places and 51 lactating cows in a series of 5-h observations during 5 different days. During the observation periods two observers recorded the cow number and the exact time of the visit to each scale. The observed data were then compared with the computer records. To validate weight monitorization, on separate days the amount of feed consumed by a cow during a visit was also measured manually with an external scale. The average time spent in a given scale by each cow determined by direct observations was similar

(7 s difference; $P=0.60$) to that determined by the computer. This small difference supports the application of the computerized system to study feeding behavior. Furthermore, the system was accurate and showed a specificity of 98.8% and a sensitivity of 99.6% for cow detections. Feed weights determined by the computer system were similar ($P=0.54$) to those measured manually with an external scale (144 g difference). This implies that the system was also accurate in measuring individual intake weights. In conclusion, the system allows for studying the number of visits per animal, length of each visit, amount of feed consumed per visit and animal, the total amount of feed consumed daily by each animal, and the rate at which animals consume feed.

Key Words: Feeding Behavior, Dairy Cow, Monitorization

W183 A comparison of three animal welfare assessment programs on California dairies. C. L. Stull¹, B. A. Reed^{*2}, and S. L. Berry¹, ¹University of California Cooperative Extension, Davis, ²University of California Cooperative Extension, Orland.

Due to increasing awareness of animal welfare issues by consumers, three voluntary programs have been developed to assess animal welfare on commercial dairies in the US. These programs include Humane Farm Animal Care (HFAC) with minimum standards and a third party audit system, the Dairy Quality Assurance Center and the University of California, Davis (UCD) programs with self-assessments. All three of the welfare assessment programs cover similar topics such as nutrition, housing, handling, and health. However some recommendations and standards vary between the programs. The objective of this study was to compare the three animal welfare assessment programs on commercial California dairies by using a questionnaire, combining specific criteria from each program. The survey was administered to 10 commercial dairies located in the central valley of California. The survey combined 316 statements from DQAC checklist, the UCD assessment, and the HFAC standards. The mean percent (\pm s.d) compliance for the DQAC, HFAC, and UCD programs is 83 ± 8 , 94 ± 3 and $85 \pm 6\%$, respectively. A ranking order from 1 to 10 was assigned to each dairy using the compliance score for the individual assessment program. The comparison between programs of rank order by Spearman correlation statistical analysis was not significant in any comparison indicating that different indices were being measured by each program. The results of this survey indicate that selection of the available assessment programs for animal welfare on the dairy is important in determining the outcomes. A compliance score range for each program should be defined that is considered acceptable to retailers and will assure consumer confidence in dairy food products.

Key Words: Animal Welfare, Dairy Cow, Auditing

W184 Effects of feed barrier design on feeding and social behavior of loose housed dairy cows. M. I. Endres^{*1}, M. A. G. von Keyserlingk², T. J. DeVries², and D. M. Weary², ¹University of Minnesota, St Paul, ²The University of British Columbia, Vancouver, Canada.

The objective of this study was to evaluate the effects of two feed barrier systems on feeding and social behavior of dairy cows. Forty-eight lactating Holstein cows were housed in four pens each with 12 sand-bedded stalls in a free stall barn. Cows were randomly assigned to one of two starting conditions: access to the feed alley via a neck rail or via headlocks in a completely randomized block design repeated over time. Cows were kept on one of the two conditions for 8 d, then switched to the alternative treatment for another 8 d. Feeding behavior was assessed using presence at the feed bunk, scored with scan sampling at 10-minute intervals from 24-h video. These scans were also used to estimate the percentage of cows feeding during the 90-min period following the delivery of fresh feed. Aggressive displacements from the feed bunk were scored continuously from video during these same 90-min periods. Average daily feeding time did not differ ($P > 0.2$) when cows had access to feed via headlocks (271.7 ± 3.8 min per day) compared to the post and rail barrier (277.8 ± 3.8 min per day). There tended ($P = 0.06$) to be a greater percentage of cows present at the feed alley during the 90-min morning period when using the post and rail barrier ($57.0 \pm 1.5\%$) compared with the headlocks ($50.8 \pm 1.5\%$), but there was no evidence of a difference ($P > 0.2$) during the afternoon feeding. There was also no difference ($P > 0.1$) in the number of displacements performed during the 90 min after feeding when the cows had access to the feed via headlocks versus post and rail barrier (0.71 ± 0.14 and 1.10 ± 0.14

displacements per cow per day, respectively). Although the post and rail barrier may allow for greater access to feed during high use periods, these results indicate that the type of feed barrier has no effect on daily feeding times and incidence of aggressive behavior at the feed bunk.

Key Words: Feed Barrier, Feeding Behavior, Dairy Cow

W185 The effect of feed intake levels on behaviors of transition dairy cows. K. J. Daniels*, J. R. Townsend, S. S. Donkin, E. A. Pajor, A. G. Fahey, and M. M. Schutz, Purdue University, West Lafayette, IN.

Our objective was to characterize feeding behaviors of transition cows fed for different intake levels. Thirty Holstein cows were blocked by expected calving date and randomly assigned to treatments. Control cows (CC) were provided feed for ad libitum intake; restricted cows (RC) were fed to 75% of estimated intake; and stuffed cows (SC) were forced through rumen cannulas to 100% of estimated intake. Cows were housed in tiestalls from 28d prior to expected calving and treatments imposed from 15d prior to expected calving through the day of calving. All cows were fed for ad libitum intake post-calving. Cows were video-taped 24 h/d, using time-lapse video recording, during treatments and until 14d after calving. On d -15, -6, -2, 2, 8 and 13 relative to actual calving, durations of standing (S), lying (L), feeding (F), ruminating (R), feeding while standing (FS), ruminating while standing (RS) and ruminating while lying (RL) behaviors were measured. Treatment affected FS (3.40 h for CC, 2.64 h for RC, and 2.98 h for SC; $P<.01$) and F (3.48 for CC, 2.83 h for RC, and 3.05 h for SC; $P<.01$). Treatment by d affected RS ($P<.05$). As cows approached calving, RS was maintained for RC, but increased for CC and SC. Time spent RS decreased dramatically for SC, was maintained for RC, and increased for CC immediately after calving. Differences among treatments after d 2 were not significant. Day affected all treatments for S, FS, L, RL, F, and R ($P<.01$). Time spent S, FS and RS increased prior to calving, decreased immediately after calving and returned to baseline at d 13. Time spent L decreased over the entire time period for all treatments. Duration of R dropped through d 2 then steadily increased for all treatments. Restricting intake levels prior to calving reduced feeding duration, but it also slowed increases in time spent RS compared to CC after calving. Force feeding cows encouraged RS, but RS dropped after calving when force feeding was ended. Restricting intake levels leads to reduced time spent feeding and ruminating while standing after calving.

Key Words: Dairy Cattle, Behavior, Transition

W186 Suckling latency in neonatal Holstein calves. H. E. Carpenter*, J. S. Birney, and K. A. Koudele, Andrews University, Berrien Springs, MI.

Neonatal suckling behavior is critical for calf survival. The objective of this study was to determine if the latency of neonatal calf suckling behavior was correlated with the percentage of inbreeding, calf birth weight, calf gender, difficulty of birth (dystocia), or dams Johnes status. Holstein calves ($n=372$) were evaluated for suckling response when first offered a bottle of warm colostrum. The latency score was on a scale of 1-5: 1=started nursing within one minute, 2=started nursing within 5 minutes, 3=offered bottle again at next regular feeding time and started nursing within one minute, 4= started nursing within 5 minutes, 5= needed to be oro-gastric tube fed at next feeding. Dystocia level was scored 1-4: 1=no assistance, 2=minor assistance, 3=mechanical pull, 4=hard mechanical extraction. The dams Johnes status was either negative or positive. There were 286 calves with a latency score of 1 (77%). There were 86 calves with scores of 2-5 (2=8.6%, 3=10.0%, 4=1.9%, 5=2.7%). No significant difference was found among the groups for birth weight, gender, dystocia score, or dams Johnes status. There was a significant difference between the percentage of inbreeding and latency of suckling score for group 1 vs groups 2-5 ($p=.004$). Calves with the score of 1 had an average inbreeding of 4.8%. Those with a score of 2 or greater had an average inbreeding of 5.4%. Inbreeding percentages were calculated from the Holstein Associations Inbreeding Calculator. The Holstein breed average is 4.5%. The slow-to-nurse calves require more time and effort from the calf feeding staff increasing dairy labor costs. The increased suckling latency of neonatal calves may be an unintended consequence of selection for increased milk production over the past 50 years. The percentage of inbreeding is also of concern not only on how it affects suckling in the neonate but also on other aspects of

cow productivity such as disease resistance, reproductive parameters, and longevity.

Key Words: Calf Suckling Behavior, Inbreeding

W187 Subsequent effects of an environmental enrichment in the early fattening stage of beef cattle on their behavior, physiology and productivity. T. Ishiwata*¹, K. Uetake¹, N. Abe², Y. Eguchi¹, and T. Tanaka¹, ¹*School of Veterinary Medicine, Azabu University, Sagami-hara, Japan*, ²*Faculty of Agriculture, Tamagawa University, Machida, Japan*.

We have reported the effects of an environmental enrichment with a drum can in the early fattening stage of beef cattle (*J. Anim. Sci.* 81 (Suppl. 1), 2003). The subsequent effects of the enrichment in the middle and finishing stage were investigated. Seventy-one Japanese Black × Holstein steers were allocated, in two repetitive experiments, to 3 pens (6.0×9.5 m each): Pen C (control, n=11 and 12) that consisted of a feeding alley for grain feed, a trough for dry hay, a water bowl and resting space; Pen D (n=12 and 12) that a drum can (Φ58×H 90 cm) that contained hay was added to the control pen; Pen GD (n=12 and 12) that a drum can that was put around an artificial turf (30×120 cm) for grooming was added. The drum cans were removed after 5 mo. Behavioral observations were made for 2 h at 10 min intervals after morning and evening feedings for 3 d at 0, 1, 3 and 5 mo after their removal. Jugular vein blood samples were collected and body weight recorded at 1, 3 and 5 mo after their removal. ANOVA, a post-hoc test and a correlation analysis were performed. Although the drum cans had encouraged hay eating during their installation, the number of eating became smallest in Pen GD (P<0.05) after their removal. The number of investigating bars became larger in Pen GD than in Pen C, in which more steers had licked bars (P<0.05). The number of stand-resting became largest in Pen GD, in which steers had been more active (P<0.05). Serum total cholesterol concentrations became higher in Pen D and GD than in Pen C after the removal of the drum cans (P<0.05). Beef belly was thicker in Pen D and GD than in Pen C (P<0.01). In Pen GD, the number of eating from the drum can ($r_s=0.79$, P<0.01) and grooming with it ($r_s=0.63$, P<0.05) correlated with beef marbling. Drum cans installed in the early fattening stage sustained positive effects even after their removal and improved the final productivity of beef cattle.

Key Words: Beef Cattle, Environmental Enrichment, Behavior

W188 Effect of increasing sodium bicarbonate proportion in high concentrate diets on performance, intake, water consumption and feeding behavior in finishing beef heifers. L. González*, A. Ferret, S. Calsamiglia, and X. Manteca, *Universitat Autònoma de Barcelona, Spain*.

Four rumen fistulated Holstein heifers (264 ± 12 kg initial BW) were used in a 4 × 4 Latin square design to determine the effect of increasing levels of sodium bicarbonate (0, 1, 2 and 4 %, on DM basis) on performance, intake, water consumption and feeding behavior. Heifers were allowed to consume concentrate and barley straw on an ad libitum basis, which resulted in a mean forage to concentrate ratio of 12 to 88. Behavior was measured by using scan sampling at 5 minute intervals. Linear, quadratic and cubic effects were analyzed with the Type 1 analysis of variance of the PROC MIXED procedure of SAS with animal and period considered random effects. There was a linear decrease in concentrate DMI (P < 0.05) and a linear increase in straw DMI (P < 0.01) with increasing buffer proportion in the diet, resulting in a linear decrease (P < 0.10) in total DM intake. Protein intake had a linear decrease (P < 0.05) with increasing buffer proportion, but there was no effect on NDF intake. Average daily gain decreased linearly (P < 0.05) with increasing buffer proportion in the diet, from 1.46 to 0.52 kg/d. When water intake was expressed as L/d or % BW, no effects were found, but it increased linearly when expressed as L/kg DM intake (P < 0.05). Moreover percentage of total daily water drunk in the morning (from 0830 to 1230) increased linearly (P < 0.05) with increasing buffer in the diet. Buffer concentration did not affect feeding behavior. Animals spent 19.4 ± 1.25, 8.9 ± 0.42, 2.5 ± 0.16 and 55.5 ± 1.85 percent of the time ruminating, eating, drinking and resting, respectively. The lack of effect on time spent ruminating with a linear increase in straw intake could be due to a reduced concentrate intake. Results indicate that overdosing

sodium bicarbonate to finishing heifers fed high concentrate diets may result in a decreased DM intake and animal performance.

Key Words: Beef Heifers, Intake Behavior, Sodium Bicarbonate

W189 Can sheep learn to minimize the length of their foraging path? A. J. Rook* and J. E. Cook, *Institute of Grassland and Environmental Research, North Wyke, Okehampton, Devon, UK*.

Sheep exploit spatially heterogeneous food resources by selective foraging at preferred patches. But can they minimise the distance traveled to exploit a given set of patches? We laid out a 10 × 10 grid of bowls at 4m spacing in a bare earth arena, filling each of 10, 20, 30, 40 or 50 bowls with 25g concentrate feed (patches). We used a different dry ewe and different random patch positions for each of 3 replicates of each treatment. Each ewe foraged in the arena for 20 min on each of 5 successive days. We recorded the distance the ewe travelled before finding 5 patches and compared this with the shortest possible distance and with the expectation from a random walk. The distance to 5 patches on day 5 was 0.37 that on day 1 for the 10 patch treatment but only 0.67 for the 50 patch treatment. For the 10 patch treatment the distance on day 1 was 4.59 times the shortest possible path but only 1.78 times by day 5. Values for the 50 patch treatment were 2.11 and 1.38. Even on day 1 distance travelled was significantly (P<0.001) shorter than for a random walk as when leaving any bowl (full or empty), ewes continued in the same direction as they had approached it on 64% of occasions. In conclusion after 5 days of learning ewes were close to minimising the distance travelled to find 5 patches. Learning was more marked when the resource was more scarcely distributed. The path taken was always shorter than a random walk.

Key Words: Foraging, Sheep, Optimisation

W190 We have ways of getting you to.... behave! J. K. Haskell* and F. D. Provenza, *Department of Forestry, Range and Wildlife, Utah State University, Logan, UT*.

Our goal is to increase the use of knowledge of behavior to better reconcile ecological, economic, and social facets of management by conducting outreach, education, and research activities that will: (1) improve economic viability and ecological integrity of pasture- and range-based enterprises, (2) enhance and maintain biodiversity of rangelands, (3) restore pastures and rangelands dominated by weeds, (4) optimize wildlife benefits to land owners, managers, and users, (5) mitigate livestock abuse of riparian areas, (6) improve our ability to manage complex adaptive systems. Behavioral principles and practices, once mastered, provide an array of solutions to the problems people face in managing and improving the integrity of the land. Unlike the infrastructure of a ranch such as corrals, fences, and water development, behavioral solutions cost very little to implement and they are easily transferred from one situation to the next. We know the environment interacting with the genome creates behavioral responses. An animals experience of this *in utero* and in early in life is especially critical, and continues throughout life. Thus, animals are in the process of adapting to ongoing changes in social and physical environments every day of their lives. Therefore, those willing to understand how environments interact with the genome to influence behavior, have unlimited potential to shape change. The challenge becomes understanding and applying behavior principles. To further that goal, rather than developing and transferring technology packages, we aim to change, fundamentally, the way people understand and use behavior to manage ecosystems. We want people to realize the power of behavior to transform systems ecologically, economically, and culturally. We are involving producers, land managers, extension, and technical assistance personnel in various education and outreach activities, fact sheets, booklets, videos, slide shows, demonstrations, symposia, workshops, and courses. We also have developed a web site (www.behave.net) in concert with the national Agriculture Network Information Center (AgNIC) - to disseminate information about the project.

Key Words: Animal Behavior, Biodiversity, Foraging

W191 Effects of fescue toxicosis on CYP3A4 in rats at thermoneutrality. R. S. Settivari*, V. C. Dhulipala, P. A. Eichen, L. E. Wax, T. J. Evans, G. E. Rottinghaus, and D. E. Spiers, *University of Missouri, Columbia*.

Fescue toxicosis is caused by the consumption of toxins found in endophyte infected tall fescue. Cytochrome P450 (CYP) enzymes play an important role in Phase I metabolism of many xenobiotics with CYP3A4 being the dominant CYP in liver. The present study determined if rats fed a diet containing infected fescue toxins (E+) induced CYP3A4. Rats (n=24) were implanted with temperature transmitters to measure core temperature (Tc) and activity every 10 minutes during the study. Following an eight day recovery, rats were fed ground endophyte-free (E-) feed for five days. During the five day treatment period, rats were fed ad libitum either an E- or E+ diets (91.5µg EV/kg BW/day). At the end of treatment, rats were euthanized and liver, adrenal, kidney, heart and testis were weighed. Feed conversion efficiency was calculated for both groups. Serum prolactin levels were measured using enzyme immuno assay. Histological sections of liver were analyzed by electron microscopy. Protein levels of CYP3A4 in liver were analyzed using Western blots. E+ treatment lowered body weight, relative liver weight, feed intake, Tc, and serum prolactin levels (P< 0.05). E+ treatment increased relative testes weights (P<0.05) but had no significant effect (P>0.05) on adrenal, kidney and heart weights. Histological section of liver showed numerous vacuolations between the hepatocytes. Feed intake, weight gain and feed conversion of E+ rats began to return to normal levels near the end of treatment. Protein expression level of CYP3A4 was greater (P<0.05) in E+ rats compared to E- group. This may be due to increased expression of CYP3A4 protein, and could reduce levels of E+ toxins and some of the symptoms in E+ rats after the fourth day of treatment. Future studies should evaluate the rate and time course of CYP3A4 induction and activity in rats fed endophyte-infected fescue diet under acute and prolonged heat stress conditions.

Key Words: Fescue Toxicosis, Cytochrome p450, Rat

W192 Dose-response relationship between ergovaline and physiological changes associated with fescue toxicosis. P. A. Eichen*, D. E. Spiers, and G. E. Rottinghaus, *University of Missouri, Columbia*.

Rats fed an endophyte-infected fescue (E+) seed diet experience changes in core temperature, feed intake and weight gain similar to those seen in cattle consuming E+. A study was performed to determine dose differences in response to ergovaline (EV), the primary toxin found in E+ seed, and identify sensitivity of the above parameters. Male rats (n=24) were implanted with telemetric transmitters (Mini-Mitter, Inc.) to record core temperature (Tc), and randomly assigned to either endophyte-free diet (E-) or E+ diet delivering low (30.5µg EV/kg BW/d), medium (61.0µg EV/kg BW/d) or high (91.5µg EV/kg BW/d) levels. Feed intake and body weights were recorded daily. Rats were maintained at thermoneutrality (TN; 21°C) during pretreatment and the first seven days of treatment, followed by seven days of heat stress (HS; 31°C). At the end of HS, all rats were euthanized for measurement of organ weights. Feed intake decreased at TN in all E+ groups compared to E- rats (P<.0001), with a greater reduction in the high compared to low E+ rats (P<.05). During HS, all E+ groups had lower feed intake than E- rats (P<.0001). Maximum reductions in feed intake below pretreatment levels at TN were 47, 42 and 20% for high, medium and low E+ groups, respectively, with additional reductions of 19, 18 and 38% during HS. However, there was recovery of feed intake in both TN and HS periods. Body weights were not different for any treatment group at TN, but rats fed high and medium E+ diets had decreased body weights compared to low E+ and E- groups during HS (P<.002). E+ groups were not significantly different from one another for Tc, so were combined for analysis. There was a treatment by day interaction during HS, with E+ rats displaying a slightly higher Tc (P<.0001). Liver weights, relative to body weights, were decreased in all E+ groups compared to E- rats (P<.0006). These results indicate that feed intake and Tc responses associated with fescue toxicosis are separate events, with feed intake being much more sensitive.

Key Words: Fescue Toxicosis, Heat Stress

W193 Housing effect on behavior and physiology during feed-withdrawal molt in laying hens: furnished cages vs. conventional cages. K. Pohle*¹ and H.-W. Cheng^{1,2}, ¹Purdue University, West Lafayette, IN, ²USDA-LBRU-ARS.

Environmental variations affect an animal's response to a stressor. This study was to examine whether an enriched environment can reduce hens' stress responses during feed-withdrawal induced-molting, which has been identified as a managerial stressor to laying hens. At 19 wk of age, White Leghorn hens were randomly assigned into conventional cages at 6 hens per cage (645 cm² floor space/hen), or furnished cages at 10 hens per cage (610 cm² floor space/hen). Furnished cages contained nests, perches, scratch pads, and dust baths (Big Dutchman, Germany). Feed-withdrawal molt was initiated at 72 wk of age. Feed was withdrawn on Day 0, cracked corn was returned on Day 7, diet was changed to pullet feed on Day 14, then to layer ration on Day 21. Physiological data were collected via blood collection on days -13, 0 (prior to feed withdrawal), 1, 5, 7 (prior to feed return), 14, 35, including serotonin, epinephrine, norepinephrine, dopamine, and corticosterone levels, and hematological parameters. Behavioral data were collected on days 0, 2, 4, 6, 8, 9, and 17 using continuous observation from 0900-0930 and 1430-1500. There were no significant differences between furnished and conventional cages in overall hormone levels and heterophil:lymphocyte ratio during the molting period (ANOVA, P>0.05). Behavioral observations during the feed withdrawal period indicated that hens in conventional cages spent more time sitting on the cage floor than hens in furnished cages (ANOVA, P=0.04). Hens in conventional cages also spent more time inactive than hens in furnished cages (ANOVA, P=0.005). Hens in both conventional and furnished cages increased their time spent preening (ANOVA, P=0.004) and exploratory pecking (ANOVA, P<0.001) following feed withdrawal. In furnished cages, compared to their behaviors before molt, hens increased dust bath usage (ANOVA, P=0.01) during the feed withdrawal period. These results indicate that housing conditions do not fully compensate for the physiological stress induced by feed-withdrawal induced-molt.

Key Words: Molt, Furnished Cages, Welfare

W194 Effects of acute stress on physical and hormonal response in three genetic strains of laying hens. L. Jefferson* and H. W. Cheng, *United States Department of Agriculture, Agricultural Research Service, Livestock Behavior Research Unit, West Lafayette, IN*.

Genetic selection for enhanced production may also affect animals' abilities to cope with stress. In this experiment, the effects of acute stress on physical and hormonal responses were examined in three genetic lines of laying hens: a line selected for high group productivity and survival (KGB), a line selected for low group productivity and survival (MBB), and a commercial line (DXL). All genetic lines were reared in separate cages in two environmentally controlled rooms, at 4 hens/cage (144 in²/hen). At 17 weeks of age, hens housed in one room were transported to a laying facility and re-caged (transport and mixing stress). The re-caging procedure ensured that all hens were unfamiliar, with a single genetic line in the cage. Hens housed in the second room were reared without interruption and served as controls. Both control and stressed hens were sacrificed 24 hours after treatment. Tissue samples and physical characteristics, including body weight, right adrenal gland, and blood, were collected and analyzed for physiological parameters associated with the stress response. There were no significant differences in heterophil to lymphocyte ratios, relative adrenal weights and plasma corticosterone levels among the control hens from all three lines (P>0.05). Compared to their respective controls, the MBB hens tended to have a greater ratio of heterophils to lymphocytes (P=0.06) than the KGB and DXL hens. The relative weight of the right adrenal gland was significantly increased in the KGB hens (P<0.001) but not in the MBB and DXL hens when compared with their respective controls (P>0.05). Compared to the respective controls, plasma corticosterone levels were increased in both KGB hens and DXL hens (P<0.05) but not in the MBB hens (P>0.05). This data supports the hypothesis that genetic selection affects physical and physiological characteristics which may be indicative of animals' abilities to cope with stress.

Key Words: Chicken, Acute Stress, Genetic Selection

W195 Can perches and platforms affect the incidence of gait abnormalities in broiler chickens? C. Falcone*^{1,2}, J. A. Mench², and P. Wakenell³, ¹*Departamento de Psicologia, Universidade de São Paulo, CAPES, Brazil*, ²*Department of Animal Science, University of California, Davis*, ³*Department of Health and Reproduction, School of Veterinary Medicine, University of California, Davis*.

Gait abnormalities affect millions of commercial broilers reared each year. Previous studies demonstrated that exercise can improve bone strength and decrease leg problems. We examined the incidence of gait abnormalities in Ross broilers (N=312) raised in either enriched or standard pens. Enriched pens contained two platforms and two perches. Perches and platforms were 8cm above the floor, and platforms were connected to the feeders so birds had to use them in order to reach the food. The following measurements were taken: gait, measured using the latency to lie (LTL) test, number of jumps (JMP) during the LTL test, final body weight (BW), and the incidences of tibial dyscondroplasia (TD) and femoral head necrosis (FHN). T-tests and chi-square tests were used to compare means and proportions. Final BW (controls 3.01 kg, enriched 2.96 kg) did not differ between treatments ($p=0.139$). Mean LTL was significantly greater for enriched than control birds (403 vs. 274 sec respectively, $p \leq 0.009$). Mean number of JMP was also significantly ($p=0.009$) higher for enriched (1.12) than control (0.77) birds. TD was found in 19% of enriched birds and 14% of control birds, although this difference was not significant ($p=0.297$). FHN was present in 9% of both enriched and control birds ($p=0.869$). Enrichment did not have clear effects on the specific leg problems that we measured. However, low LTL scores are a measure of impaired gait, and these results therefore indicate that enriching the environment to increase exercise can improve the walking ability of broilers. This project was funded by USDA Award No.2001-02498.

Key Words: Broilers, Gait Abnormalities, Enrichment

W196 Evolution of nursing behavior in Meishan-derived and white sows subjected to an auditory stimulus to decrease nursing intervals throughout lactation. C. Farmer* and S. Robert, *Agriculture and Agri-Food Canada, Dairy and Swine R & D Centre, Lennoxville, Canada*.

The impact of playbacks of recorded sow gruntings on the development of nursing behavior in sows from two genotypes was studied. Yorkshire x Landrace (YL; n = 16) and 25% Meishan (MH; n = 16) sows were equally divided in two groups: 1) no playback, and 2) playbacks of recorded sow gruntings at 35-min intervals. Recordings were played from d 110 of gestation until d 27 of lactation. Sow behavior was videotaped for 24 h every four days, from d 6 to 26 of lactation. Playbacks decreased nursing intervals in MH (34.9 vs 38.2 ± 1.1 min) without altering it in YL (37.9 vs 36.5 ± 1.1 min; breed x treatment, $P < 0.05$), yet this effect in MH was likely due to the increased frequency of non-productive nursings seen on d 6, 10 and 14 ($P < 0.05$) in sows subjected to playbacks. In both breeds, the interval between nursings increased ($P < 0.01$) from d 6 (33.7 ± 0.8 min) to 26 (40.8 ± 0.8 min) of lactation, the interval between non-productive nursings remained similar ($P > 0.1$) and sows ended more nursings as lactation advanced ($P < 0.01$). More nursings were terminated by sows in MH than in YL ($P < 0.01$) whereas more nursings were terminated by piglets from YL than MH sows ($P < 0.05$). Playbacks or genotype did not alter the amount of time over a 24 h period that sows spent standing, sitting, lying on the belly or lying with their udder exposed ($P > 0.1$), but sows spent more time sitting, standing and lying on their belly and less time lying with their udder exposed as lactation advanced ($P < 0.01$). Posture changes were more frequent for MH than YL sows ($P < 0.01$) and increased as lactation advanced ($P < 0.01$). In conclusion, the effects of playbacks on nursing behavior varied across genotypes and all recorded sow behaviors changed as lactation advanced. Piglets from MH sows seem to play a greater role than piglets from YL sows in optimizing lactation performances, as suggested by their lower willingness to end nursings.(Thanks to Hypor (formerly Genex Swine Group) for supplying the animals).

Key Words: Nursing Behavior, Meishan, Sows

W197 Trickle versus drop feeding for gilts and sows in gestation crates or pens: reproductive performance and rates of injury. J. McGlone¹, L. Hulbert*¹, J. Dailey², R. McPherson¹, and J. Morrow², ¹*Texas Tech University, Lubbock*, ²*USDA-ARS*.

Sow housing systems and their effects on sow welfare are important to pork producers and consumers. Specifically, we sought to evaluate the effects of trickle feeding (feed delivered over 30 min) vs. drop feeding (feed delivered in a single moment) for PIC-USA Camborough-22 gilts/sows housed in gestation pens (groups of 5) or individual crates. Gilts were randomly assigned to one of the four factorially-arranged treatments. A total of 8 blocks were established. Pregnant gilts all farrowed in standard farrowing crates and then they returned to their same environment for a second complete parity. A total of 188 litters were farrowed from parity 1 and 2 females. Measures included backfat thickness, farrowing rates, numbers of pigs born alive, weaned, stillborn and piglet birth and weaning weights. Sow weights were collected at farrowing and weaning. Sow injuries, wounds and scratches were quantified. No interactions between parity, housing systems or feeding systems were observed. The interaction between housing and feeding systems was significant ($P = 0.01$) for only sow farrowing weights; drop-fed, penned sows were heavier than drop-fed, crated sows while trickle-fed, penned sows were lighter than trickle-fed, crated sows. Penned sows had more ($P < 0.05$) backfat thickness than crated sows. Drop-fed sows weaned pigs were heavier ($P < 0.05$) than trickle-fed sows. All other measures of productivity were not different among treatments. Injuries, wounds and scratches were statistically similar for sows in each treatment group. Drop-fed, penned sows increased backfat thickness compared with crated sows (perhaps being able to huddle, penned sows required less feed), but this effect was eliminated when penned sows were trickle-fed (and energy expenditure may be increased). Farrowing rates were 10% lower among penned than crated sows. We conclude that overall gilt and sow productivity and injury rates were similar for sows in crates and pens, with the exception that farrowing rates may be reduced among sows housed in social groups during gestation.

Key Words: Pigs, Gestation Housing, Welfare

W198 Performance and longevity of gestating sows housed in pens with electronic sow feeder (ESF) and in individual stalls. L. Anil*¹, S. Anil¹, S. K. Baidoo², and J. Deen¹, ¹*Department of Veterinary Population Medicine, College of Veterinary Medicine, University of Minnesota, St. Paul*, ²*Southern Research and Outreach Center, University of Minnesota, Waseca*.

A study was conducted at the University of Minnesota Southern Research and Outreach Center, Waseca, MN with 206 sows (body weight 171-259 kg, parity 1-4) housed in four pens (2 mixings per pen at 14 days interval after weaning) with fully slatted floors (12.75m long X 6.75m wide) and a single walk through ESF located at the center of each pen and 176 sows (body weight 140-278kg, parity 1 to 5) housed in stalls (length 200cm X width 60 cm X height 97cm, with fully slatted floors) to compare the farrowing performance and longevity of sows. All the sows stayed in gestation stalls for the first 10 days following weaning before moving to allotted treatments. The means of performance in each group were compared using Independent-samples T test. A higher conception rate compared to sows in pens with ESF (74.76%) was observed in stall-housed sows (81.81%). There was no significant difference in performance between sows housed in pens with ESF and in stalls in terms of litter size, born alive /litter, stillborn /litter and foster-on. Stall-housed sows had significantly ($P < 0.05$) less number of mummies/litter (0.67 vs. 0.86) and higher foster-off (0.67 vs. 0.79) than group-housed sows. Piglet death /litter (1.22 vs.1.58) and pre-weaning mortality (13.16 vs. 16.24) were significantly ($P < 0.05$) lower in group-housed sows. Of the 17 sows removed from the pens with ESF, 11 were removed for lameness. Five sows were removed from stalls including one for lameness. Proportion of sows removed from the pens with ESF was significantly higher ($P < 0.05$) than sows in stalls. Results indicated that group pens with ESF need modification to improve farrowing percentage and sow longevity.

Key Words: Pens with ESF, Gestation Stall, Sow Longevity

W199 Novel arena/object test to assess housing related stress in gestating sows housed in stalls and in pens with electronic sow feeders (ESF). L. Anil*¹, S. Anil¹, S. K. Baidoo², and J. Deen¹, ¹*Department of Veterinary Population Medicine, College of Veterinary Medicine, University of Minnesota, St. Paul*, ²*Southern Research and Outreach Center, University of Minnesota, Waseca*.

Novel object/ arena test was conducted on day 108 of gestation among sows housed in stalls (29 sows) and in pens with ESF (36 sows) to assess the fearfulness of sows when exposed to a novel arena and/or novel object as a measure of the housing-related stress experienced by the sows. A completely enclosed rectangular pen (4.78 m X 2.4 m) was divided into 10 equal segments and numbered one through 10. In the middle, opposite from the side of entrance a semicircle of radius 0.5 m was marked off (area A) for placement of the novel object, a fluorescent orange safety cone. The sows were moved into the pen, one at a time directly from their daily environment. The sow was observed for the first two minutes for the areas it entered within the arena. The sow was considered to be in an area if the snout entered the area. The novel object was placed in area A for the next three minutes and the sow was observed. Data on areas entered, time to approach the object, total time spent in the area A, time to first interaction with the object and number of interactions were recorded. The results of the test were compared using independent sample T-test and Kruskal-wallis ANOVA. More stall-housed sows (16) entered the area with novel object than sows housed in pens with ESF (13). Stall-housed sows took significantly less time (72.5 s) to enter the area with novel object than sows from pens with ESF (112.6 s). There was no significant difference among sows from both systems in terms of number of squares entered, time to have the first interaction and number of interactions with the novel object. The results were inconclusive as there was no possibility to account for the excitement in stall-housed sows when they were permitted to have a short walk and in a larger area during the test and the individual differences among sows.

Key Words: Novel Arena/Object Test, Pens with ESF, Gestation Stall

W200 The effect of cold draft on behavior of newly weaned piglets. A. Bruni* and T. M. Widowski, *University of Guelph, Ontario, Canada*.

Adverse barn environments resulting from poor ventilation or improper temperature control are often blamed for the development of vices in pigs. Behavior problems that can develop at weaning include ear biting, navel sucking and belly nosing. While it is evident that cold, drafty conditions can lead to reduced performance and health problems, any relationship with oral/nasal behavior has never been explored. The objective of this study was to determine the effect of cold draft on oral/nasal behavior in piglets weaned at 18-22 d of age. Sixteen Yorkshire piglets were used in each of 5 trials (n=80) comprising 2 pens per treatment and 4 piglets per pen. Piglets were housed in an environmental chamber in which half of the pens could be exposed to cold draft while the other half maintained at recommended temperature and air velocity. Treatment piglets were kept at 27.9 (+0.58)°C except when subjected to 2-one h periods of time-unpredictable draft each day during which temperature was decreased 3°C and air velocity increased to 0.8 m/s at

pig level. Control pigs were kept at 28.1 (+0.63)°C with minimal air movement of <0.3 m/s. Behaviors were observed on d 3, 5, 7, 9, 12 and 15 using scan sampling every 5 minutes for 6 h per day. Overall, piglets exposed to draft spent significantly less time engaged in belly-nosing behavior (0.59 + 0.18%) and more time at the feeder (12.46 + 0.68%) compared to controls (1.32 + 0.34% and 9.46 + 0.69%, respectively; P<0.05). Yet, overall feed intake and growth rates did not differ for the two groups (P>0.05). During periods of cold draft, treatment piglets were more active (17.7 + 0.02%) and spent more time nosing and chewing their pen-mates' ears and tails (1.6 + 0.01%) compared to controls (14.3 + 0.01% and 1.1 + 0.01%, respectively; P<0.05). These results show that exposure to cold draft stimulates nosing and chewing pen-mates' ears and tails but not belly nosing. Adverse environmental conditions may contribute to some oral/nasal behaviors but not others.

Key Words: Piglet Behavior, Belly Nosing, Cold Draft

W201 Analysis of euthanasia and death in swine breeding herds. S. S. Anil*, L. Anil, and J. Deen, *Department of Veterinary Population Medicine, College of Veterinary Medicine, University of Minnesota, St. Paul*.

The pattern of sow deaths and euthanasia and the factors influencing the likelihood of sows to be euthanized or to have a natural death among the removed sows in commercial swine breeding herds were analyzed retrospectively, involving 24,017 records of death and euthanasia from 17 herds from 1999 to 2003. Logistic regression models were fitted to analyze the association of euthanasia with production variables, season and remove day. Of all the females died and euthanized, 23.6 % were euthanized and 16.3 % of females were euthanized for painful conditions. Among the sows and gilts those experienced painful conditions, 67.28% and 58.38% respectively were euthanized. The percentage of euthanized sows (5.2) was higher than that of death (3.4) on farrowing day. The euthanasia to death ratio was lower up to 15 days post-farrowing (0.27 on day 15) and then increased with the peak (0.63) during 31 to 35 days post-farrowing. The proportion of deaths was lower during week-ends. As average number of stillborn/litter increased, the likelihood for euthanasia increased among sows (OR 1.067). Sows of parity 1 and 2 were more likely to be euthanized compared to sows of parity >5 (OR 1.121). The odds of euthanasia was less for lactating sows (OR 0.410) than for non-lactating sows. In sows and gilts, the likelihood for those that were never served to be euthanized was higher (OR 2.423 and 1.686 respectively) compared to those served once. The likelihood was lower (OR 0.86) for sows that were served more than once compared to those served once. The likelihood for euthanasia was higher during weekdays (OR 2.824). The farm had a significant influence on the odds for euthanasia. Average number of litters farrowed / year, average number of non-productive days / parity, average number of pigs born alive / litter, average number of mummies / litter and born alive, mummies and stillborn in the removal parity were not significantly (P>0.05) associated with likelihood for euthanasia among sows. The results indicated that sows were at different likelihoods of euthanasia, depending on stage of production. An effort should be made to ensure that care and pain amelioration are available at all stages of production.

Key Words: Euthanasia, Death, Sow

ADSA Growth and Development

W202 Effects of weaning and ionophore on selected blood metabolites and growth in dairy calves. J. L. Klotz* and R. N. Heitmann, *Department of Animal Science, The University of Tennessee, Knoxville*.

Dairy calf weaning is associated with elevated ketone levels in excess of measured rates of utilization in adults and excess concentrations excreted in urine present a potential energy loss. Lasalocid is frequently supplemented as an anticoccidial in calf starters, but in adults is also known to alter molar ratios of ruminal VFA. Jersey bull calves (n = 24) were blocked in groups of two according to birth date and weight and randomly assigned to receive either a commercial pelleted starter (C), or the same diet containing lasalocid (T; 83 mg/kg DM) to examine effects of weaning transition on weight (BW), gain (ADG), and blood glucose, β -hydroxybutyrate (BHBA), non-esterified fatty acids (NEFA), volatile fatty acids (VFA), insulin, and glucagon (GLN) concentrations over 16 wk. From d 3 - 34 all calves were fed milk replacer twice daily, d 35 - 48

received replacer and C or T, and d 49-112 received *ad libitum* C or T. Repeated measures of BW and metabolite concentrations from jugular samples were recorded weekly. Postweaning intake (2.35 vs. 2.34 kg/d; \pm 0.07), ADG (0.78 vs. 0.75 kg/d; \pm 0.03), and feed:gain (3.10 vs. 3.19; \pm 0.11) did not differ between C and T. Glucose and NEFA concentrations did not differ between C and T, but declined with age. Insulin and GLN concentrations did not differ between C and T, but GLN increased with weaning. Total VFA significantly increased following introduction of solid feed at d 35, but there was a 1-wk lag period with T. Acetate and butyrate concentrations were greater in C than T during wk 7 (P < 0.05). Propionate concentrations and acetate : propionate ratios did not differ between C and T. Blood BHBA concentrations were greater in C than T (P < 0.05) during wk 8 and 9 (1.0, 1.1 vs. 0.7, 0.8 mmol/L; \pm 0.1). Consumption of starter with lasalocid delayed peak acetate and

butyrate and lowered peak BHBA concentrations, but did not appear to significantly influence post-weaning growth or efficiency.

Key Words: Weaning, Growth, Ionophore

W203 The effects of feeding chlortetracycline on the performance of breeding age dairy heifers. E. D. Reid* and P. S. Erickson, *University of New Hampshire, Durham.*

Chlortetracycline (CTC) is a broad spectrum antibiotic that is used to increase profitability in a variety of animals by increasing weight gain, feed efficiency, carcass grades, and conception rates. The use of CTC for this purpose, however, remains controversial, in part because little is known about the mode of action of this antibiotic. The current study was designed to test the effects of CTC on rate of gain, wither and hip height, feed efficiency, body condition score, systemic thyroxine (T4) and glucose levels, and conception rates of breeding age Holstein heifers. Forty 12-mo old Holstein heifers (initial BW = 363 kg) were housed in a free stall with ad libitum access to feed and water for 104 d (transition period starting at 14 d prior to age of 12 mo and 90 d treatment period starting at 12 mo of age). The CTC-fed group (n = 20) received 350 mg of top-dressed CTC/head/d. Measurements for weight, wither and hip height, body condition score, and health score were recorded weekly. Dry matter intake was monitored daily. Blood samples were obtained every 4 d to determine systemic T4 and glucose concentrations. There was no effect of CTC on weight gain, feed efficiency, height, body condition score, blood glucose concentrations, general health or conception rate. There was an interaction (P < 0.03) between treatment and time for systemic T4 concentration. In the beginning of the experiment, systemic T4 concentration was lower in animals supplemented with CTC. There was no difference in systemic T4 concentrations between treatments at the end of the experiment.

Key Words: Chlortetracycline, Dairy Heifer, Thyroxine

W204 The effect of feeding three milk replacer regimens preweaning on heifer intake, prepubertal and pubertal growth parameters and reproductive performance. C. S. Ballard*¹, H. M. Wolford¹, C. J. Sniffen², T. Sato³, K. Uchida³, and Y. Yabuuchi³, ¹W.H. Miner Agricultural Research Institute, Chazy, NY, ²Fencrest LLC, Holderness, NH, ³Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan.

As previously reported, 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. The calves fed milk replacer as a % of body weight had a greater rate of growth for all parameters measured. Calves fed milk replacer at a fixed rate were weaned at an earlier age and had fewer days treated for illness. The objective of this study was to continue to measure the performance of these heifers from 10 to 20 weeks of age for intake and 10 weeks to 18 months of age for growth and reproductive performance. Individual dry matter intakes were measured weekly on a subset of 39 total animals from 10 to 20 weeks of age. Heifer growth was measured monthly from 10 weeks to 18 months. The calves fed as a % of body weight during the wet phase of their life had higher growth rates, resulting in larger framed animals from 2 weeks through 7 months of age. No significant differences between treatments for growth were found after 7 months.

Item	Treatment			SEM	P
	1	2	3		
Wt, kg, Mo 18	507.54	501.55	520.59	10.54	0.471
WH ¹ , Mo 18	138.17	136.21	136.91	0.58	0.073
S-P ² , Mo 18	164.65	162.78	166.66	0.78	0.071
Chest ³ , Mo 18	72.18	71.07	72.33	0.57	0.238
DMI, kg/d, 15wk	3.09 ^b	3.40 ^a	2.84 ^b	0.10	0.003
DMI, kg/d, 20wk	2.52	2.51	2.41	0.05	0.292
Age at FS ⁴ , d	444	435	432	10	0.330
Height at FS, cm	135.73	134.16	134.61	0.75	0.336
Weight at FS, kg	444.33	442.32	451.10	10.76	0.915

¹Wither height,cm,

²Shoulder to pin,cm,

³Chest depth,cm,

⁴First Service,

^{a,b}Means within a row differ (P < 0.05).

Key Words: Milk Replacer, Heifer Growth

W205 Effects of intake, selection for milk yield, and bST administration on hepatic expression of insulin receptors and components of the somatotrophic axis in growing Holstein heifers. S. H. Wu*, W. J. Weber, H. Cheser-Jones, L. B. Hansen, and B. A. Crooker, *University of Minnesota, St. Paul.*

Hepatic gene expression was determined in heifers from an unselected (since 1964) stable milk yield line (control, CL) and a contemporary line (select, SL) to assess effects of intake, selection for milk yield, and bST. 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) on d 4 to 10. Liver biopsies were collected on d 1, 8, 23, 26, 30, and 33 and mRNA for insulin receptor isoforms A and B (INSRA and INSRB), total and type-1A growth hormone receptor (GHR-t, GHR-1A), total and class-2 insulin-like growth factor-I (IGF-t, IGF-c2), and IGF-I binding proteins (IGFBP-2, -3, and -5) determined by real-time PCR. Expression, relative to hypoxanthine phosphoribosyltransferase (HPRT) was reported as relative units (ru). Results from a repeated measures analysis (PROC MIXED of SAS) differed when P < 0.05. HPRT was similar between lines but was less on d 33 (23.2^a, 23.2^{ab}, 23.3^a, 23.2^a, 23.2^a, 23.0^b ± 0.1 ru). Line had no effect on expression of any gene measured. Relative to d 1, bST decreased GHR-1A (24%), IGFBP-2 (32%), and IGF-c2/IGF-t ratio (19%) and increased INSRA (25%). Relative to d 1, feed restriction decreased GHR-1A (49%), GHR-t (40%), GHR-1A/GHR-t (22%), IGF-c2 (83%), IGF-t (58%), and IGF-c2/IGF-t (62%) and increased IGFBP-2, -3, and -5 (136, 31, 169%). INSRB and INSRB were increased (163, 121% of d1) on d 23 but similar to d 1 on d 26. There were line by day interactions for GHR-1A and for INSRB. Relative to d 1, GHR-1A decreased more in CL (66%) than SL (31%) during feed restriction. 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

W206 Effect of implant program on somatotropin (ST) response to growth hormone releasing factor (GRF) in finishing Holstein steers. B. A. Crooker*¹, W. J. Weber¹, C. Cheatham², L. H. Baumgard², and G. C. Duff², ¹University of Minnesota, St. Paul, ²University of Arizona, Tucson.

Steers (n=19) were randomly assigned to one of four implant schemes of Raigro (R), Synovex-S (S), or Synovex-Plus (P) and used to determine effects of implants on ST response to GRF. On d 1, 84, and 168, steers received no implants (controls, CON; n = 5) or implants in the sequence RSS (n = 5), RSP (n = 5), RPP (n = 4). On d 228, steers received 5 µg/100 kg BW of human GRF (1-29) analog (Hoffman-LaRoche, Ro23-7863) at 0 min (FLUSH) and 4 µg/100 kg BW GRF 150 min later (CHALL). Blood samples were obtained at -30, -20, -10, -5, 0, 10, and 20 min relative to FLUSH and at -30, -20, -10, -5, 0, 2.5, 5, 7.5, 10, 15, 20, 30, 45, and 90 min relative to CHALL. Mean pre- (-30 to 0 min;

PCST) and post-GRF administration (10 and 20 min; MNST) ST concentrations in serum were determined by RIA. Data were transformed to natural logarithms. Area under the ST response curve for CHALL was quantified (0 to 60 min; AUC60) by trapezoidal summation after subtracting PCST. Effects of implant scheme, GRF, and their interactions were assessed using GLM of SAS. Means differed when $P < 0.05$. Steers averaged 189 ± 4.3 kg BW on d 1. Body weight increased throughout the study, did not differ among implant schemes but was greater for implanted than CON steers by d 112 (370 vs 403 kg), and remained greater throughout the study. At 228 d, BW of implanted and CON steers was 546 and 478 kg. Natural logarithm of PCST was greater for CON than implanted steers (1.15a, 0.51b, 0.99ac, 0.67bc \pm 0.16 ng/ml for CON, RSS, RSP and RPP, respectively) and greater for FLUSH than CHALL (1.00, 0.66 \pm 0.11 ng/mL). Natural logarithm of MNST was similar among schemes (5.17 \pm 0.66 ng/mL) and greater for FLUSH than CHALL (5.67, 4.28 \pm 0.47 ng/mL). AUC60 for CHALL did not differ among schemes (244, 462, 609, 116 \pm 226 ng x min/mL). Sixty days after the terminal implantation, ST concentrations were less in implanted steers but ST response to GRF did not differ from non-implanted steers.

Key Words: GRF, Implant, Holstein Steer

W207 Analysis of in vivo body composition of new born calves using dual energy x-ray absorptiometry (DXA). J. Hampe*, S. Nueske, A. M. Scholz, and M. Foerster, *University Munich, GE*.

The basis of this study is a comparison of body composition among new born calves of different genetic origins. A number of 167 calves of purebred German Fleckvieh (FV), German Holstein (GH), F1 hybrids (FV x GH and GH x FV) and "F2 hybrids" (GH x F1 - mother and FV x F1 - mother) have been examined within the first week after birth. The calves were sedated with a Ketamin - Xylazin mixture, weighed on a bar scale and scanned in the whole body mode (adult normal) on a GE Lunar DXA scanner (DPX-IQ). The evaluation showed a significant genotype influence on bone mineral density (BMD) and bone mineral content (BMC). Bone mineral percentage (BMPC) is significantly affected by the mothers breeding line. In contrary, soft tissue composed of lean tissue and fat is significantly influenced by the fathers breeding line. BMD and BMC from purebred GH is significantly lower than from calves with FV father or mother. Purebred GH calves have a significantly lower BMPC than crossbred calves with GH father. Purebred GH calves reach in tendency higher values than the other genotypes with regard to the lean tissue percentage (LeanPC). However, the main difference in LeanPC and fat percentage (FatPC) exists between male and female calves with 91.24% to 91.6% lean and 4.86% to 4.52% fat. FV x GH calves reach a significantly higher FatPC than GH x FV calves showing a clear position effect in the crossbreeding program.

Breeding Line	BMC (g)	BMD (g/cm ²)	BMPC (%)	Lean PC (%)	Fat PC (%)	n
GH x GH	1605.7 \pm 64.7 ^a	.881 \pm .018 ^a	3.64 \pm .08 ^a	91.75 \pm .26	4.61 \pm .23 ^{cd}	29
FV x FV	1791.9 \pm 63.0 ^b	.943 \pm .017 ^b	3.87 \pm .08 ^b	91.49 \pm .25	4.64 \pm .23 ^{cd}	33
GH x FV	1804.3 \pm 63.7 ^{bc}	.961 \pm .017 ^b	4.02 \pm .08 ^b	91.55 \pm .25	4.43 \pm .22 ^{ac}	36
FV x GH	1789.9 \pm 62.8 ^b	.945 \pm .017 ^b	3.84 \pm .08 ^b	91.17 \pm .25	4.99 \pm .22 ^{bd}	35
GH x F1	1763.3 \pm 76.8 ^{ac}	.946 \pm .021 ^b	4.02 \pm .09 ^b	91.28 \pm .30	4.70 \pm .27 ^{cd}	22
FV x F1	1888.1 \pm 98.9 ^b	.967 \pm .027 ^b	3.93 \pm .12 ^b	91.29 \pm .39	4.78 \pm .36 ^{cd}	12

Significance ($p < .05$) among Least Squares Means is characterized by different superscripts

Key Words: Dual Energy X-Ray Absorptiometry, Calves, Body Composition In Vivo

W208 Updating growth standards for Canadian Holstein and Ayrshires. D. M. Lefebvre*¹ and R. Lacroix^{1, 2} *Dept. of R&D, PATLQ - Quebec DHI, Quebec, ²Dairy Information Systems Group, McGill University, Ste-Anne-de-Bellevue, Quebec, Canada.*

Average postcalving weight of primiparous Canadian Holstein and Ayrshire cows has increased by 10% in the last 10 years. The objective of this work was to update reference growth curves for evaluating growth of dairy heifers. Growth data were collected on 24191 heifers in 851 Quebec herds. There were 69131 weight observations (estimated by heart girth) from Holstein and 4309 from Ayrshire heifers (3.1 weight observations per heifer). Height at the withers was also collected (64192 observations

for Holsteins, 3654 for Ayrshires). Average body weight by age was compared to growth standards currently used and approximated the value for the 90th percentile ranking until 20 months of age, indicating the need to update the references for calculating percentile ranking. The observed mean growth rate declined after 20 mos, consistent with average age after calving being 28 mos. The observed mean could therefore not be used as an optimal growth curve. Median body weight after calving (HO: 580 kg, AY: 500 kg) of heifers calving between January 2001 and October 2003 (167,651 observations) was used as the target post-calving BW for percentile 50. Pre-calving BW was estimated as 110% of post calving BW, such that the median target pre-calving BW was established as 638 kg for Holsteins and 550 kg for Ayrshires. Values for percentile rank 90 were calculated (1.2975 * SD, SD = 11.553+2.295*Age for Holsteins, 8.73884+2.67656*Age for Ayrshires) as 725 kg for Holsteins and 645 kg for Ayrshires. Birth weight was estimated using the regressions equations fitted on the observed body weights (42.9 and 39.6 kg for HO and Ay, respectively). Constant weight gain from birth to pre-calving at 24 mos. of age was assumed for the entire growth period. Resulting average daily gain for percentile ranks 50 and 90 were 0.81 and 0.91 kg*d⁻¹ for Holsteins and 0.70 and 0.81 kg d⁻¹ for Ayrshires. Standard curves for height at the withers were also established, using a second degree polynomial fitted on the average height by age. Height at the withers for percentiles 50 and 90 at 24 months of age are 141 and 147 cm for Holsteins and 130 and 137 for Ayrshires. The proposed standards should be used as reference to benchmark heifer growth.

Key Words: Dairy Heifer Growth, Growth Standards

W209 Identifying ruminal drinking by measurement of respiratory quotient and methane production in preruminant calves. J. J. G. C. van den Borne*, S. J. J. Alferink, and W. J. J. Gerrits, *Animal Sciences Group, Wageningen University and Research Centre, Wageningen, The Netherlands.*

In preruminant calves, milk is bypassing the rumen by closure of the oesophageal groove and flows directly into the abomasum. Leakage from the oesophageal groove or backflow of milk from the abomasum into the rumen, however, leads to fermentation of the milk replacer and results in reduced performance, meat quality and increased mortality. Several studies have elucidated the mechanism and aetiology of groove closure. In this study (originally not designed to study ruminal drinking) the diurnal pattern of the respiratory quotient (RQ) and methane production in a bloating calf was compared with that of normal calves. Individually housed calves were studied during two, 9-day periods using indirect calorimetry. Milk replacer was fed at 1.5 x MEM and no roughage was supplied. A clinical case of ruminal drinking spontaneously developed in one of the six calves. The calf was bloating and faeces were clay-like. Nutrient digestibility and gas exchange measurements were compared between this calf and five normal calves. Apparent digestibility of crude protein (86% vs 91%) and crude fat (82% vs 92%) was depressed in the bloating calf compared with the other calves. Marked differences in RQ and methane production were observed at 1.5 h postprandially. RQ increased from 0.78 to 1.13 in the bloating calf and from 0.80 to 0.88 in the normal calves. This can be ascribed to anaerobic fermentation of the milk replacer in the rumen, which theoretically results in an infinite RQ and a concomitant production of methane. Methane production, at the same time, increased from 73 mL/kg^{0.75}/d before feeding to 428 mL/kg^{0.75}/d at 1.5 h after feeding in the bloating calf, and from 25 mL/kg^{0.75}/d to 65 mL/kg^{0.75}/d in normal calves. Based on these observations, it is hypothesised that measurement of O₂, CO₂ and CH₄ in breath 1-2 h post-feeding may provide a sensitive indicator for identification of ruminal drinking. The sensitivity of this methodology, however, needs further study.

Key Words: Calves, Ruminal Drinking, Bloating

W210 Cloning the genomic sequence and proximal promoter of bovine pyruvate carboxylase. S. M. Rodriguez*, C. A. Bidwell, and S. S. Donkin, *Purdue University, West Lafayette, IN.*

Pyruvate carboxylase (PC) catalyzes a pivotal reaction in gluconeogenesis and lipid metabolism in liver. We previously identified six unique alternative splice variants in the 5 untranslated region (UTR) of PC mRNA. These splice variants may have a role in translational regulation of PC protein abundance. The objectives of this experiment were to clone and sequence the bovine PC gene, to determine the intron/exon

organization of the 5'UTR and to identify PC promoter elements. The RPCI-42 Bovine Bacterial Artificial Chromosome (BAC) library was screened with oligonucleotide sequences corresponding to specific elements of the 5'UTR sequence of bovine PC and to a region of the coding sequence. Two BACs that hybridized to all probes were selected for further analysis. A partial restriction map of the BACs was made with oligonucleotides corresponding to the coding region and the 89 and 110 bp elements of bovine PC 5'UTR. The BAC fragments that hybridized to the oligonucleotide probes were isolated and sequenced. The sizes of the cloned genomic PC 5'UTR fragments were verified by PCR, using genomic DNA from four cows. Sequencing data confirms the existence of a 178 bp exon that contains the 68 and 110 bp sequence elements

of the 5'UTR for PC mRNA. The 178 bp exon appears to be the first transcribed exon in PC and the 68 and 110 bp 5'UTR sequences are most likely generated by alternative transcription start sites. Genomic sequence data also confirms that the 3' end of the 89 bp element is a discrete 41 bp exon. Regions within the genomic sequence adjacent to the 178 and 41 bp exons of the PC 5'UTR contain binding sites for TBP, Sp1, Ap1 and/or CEBP transcription factors. These data provide information about the arrangement of exons in the 5'UTR of PC and about putative promoter regions.

Key Words: Pyruvate Carboxylase Gene, Liver, Promoter

Physiology and Endocrinology: Reproductive Technologies and Management

W211 The effect of day six or day seven prostaglandin F_{2α} (PGF_{2α}) injections and using a disinfectant lubricant with Controlled Internal Drug Release (CIDR) inserts for estrus synchronization in dairy heifers. W. M. Graves^{*1}, A. K. McLean¹, R. C. Smith¹, J. B. Rosenberg², and B. C. Beachnau³, ¹University of Georgia, Athens, ²Fort Dodge Animal Health, IA, ³Pfizer Animal Health, Portland, MI.

Our objective was to compare d-6 versus d-7 prostaglandin F_{2α} (PGF_{2α}) injections and the effect of using a disinfectant lubricant with CIDR inserts (Eazi-Breed CIDR, Pfizer Animal Health, New York, NY) placed intravaginally for 7 d. A total of 164 heifers at two locations received PGF_{2α} (Lutalyse, Pfizer Animal Health, New York, NY, 5 mg; i.m.) on either d 6 or d 7 at the time CIDR inserts were removed. Two different types of lubricants, Safe Lube (H&W Products, Inc, Salem, OH) and Nolvalube (Fort Dodge Animal Health, Fort Dodge, IA) with Nolvasan disinfectant (0.1% chlorhexidine acetate) were used to measure effects on discharge at removal and conception. Insertion devices were dipped in Nolvasan solution (29.57mL per 3.785 L), excess fluid was shaken off, then dried with a paper towel prior to using Safe Lube for application. Insertion devices were just wiped and more Nolvalube added between heifers using the disinfectant lubricant. Data were analyzed by Chi-Square. Twenty-nine of 81 (35.80%) heifers treated with Safe Lube showed signs of vaginal discharge versus 18 of 83 (21.69%) treated with Nolvalube (P<.05). Sixty-six (81.48%) of those treated with Safe Lube were in estrus and 29 (43.94%) pregnant versus 76 (91.57%) in estrus and 40 (52.63%) pregnant for the Nolvalube heifers (NS, P=.11). Seventy-one of 82 (86.59%) heifers that were injected on d 6 were in estrus and 33 (46.48%) pregnant versus 71 of 82 (86.59%) injected on d 7 that were in estrus and 43 (47.89%) pregnant (NS). Day-6 heifers came into estrus in tighter synchrony. A total of four (5.63%) of the d-6 heifers were in estrus on d 8, 52 (73.24%) on d 9 and 15 (21.13%) on d 10. A total of four (5.63%) of the d-7 heifers were in heat on d 8, 45 (63.38%) on d 9, 18 (25.35%) on d 10 and four (5.63%) on d 11. Few discharges were seen using the disinfectant lubricant. The number of heifers in estrus and pregnant were similar for the d-6 and d-7 PGF_{2α} injections.

Key Words: CIDR, PGF_{2α} Synchronization, Disinfectant Lubricant

W212 Development of a boar semen mobility assay. A. A. Olivera, D. L. Fernandez*, and E. S. Fonda, *Department of Animal and Veterinary Sciences, California State Polytechnic University, Pomona.*

Eighteen ejaculates from six mature boars were used to develop a porcine sperm mobility assay that could be performed under field conditions. A modified densimeter was used to determine an index representing the changes in light absorbance after spermatozoa penetrated a resistance medium. The control values were subtracted from the experimental values to create the Net Mobility Index (NMI). Variables used in this experiment were incubation time (5, 10, 15 or 20 min), extender (Modena, X-Cell, MR-A or VSP), sperm concentration (1, 2, or 3 x 10⁸) cells/ml and Accudenz Resistance Media concentration (3%, 6% or 9%). Inactivated sperm cells were used as controls. NMI values were lower (P<.01) for inactivated sperm (3.16±0.22 vs 25.044 ± 0.39). NMI values increased (P<.05) with incubation time (5 min, 13.78±0.39; 10 min, 23.806±0.37; 15 min, 29.00±0.38; 20 min, 32.31±0.37). However, sperm penetration tended to stabilize over time. NMI differed (P<.05) among extenders (X-Cell, 31.42±0.37; Modena, 26.70±0.37; MR-A, 23.91±0.39; VSP, 17.53±0.39). Increasing sperm concentration

increased (P<.05) NMI (1 x 10⁸), 19.20±0.33; 2 x 10⁸), 25.28±0.33; 3 x 10⁸), 30.19±0.33), however, neat ejaculate NMI (29.511±0.39) was similar to (P>.05) NMI for 3x10⁸ cells/ml. NMI differed (P<.05) among the three concentrations of resistance media (3%, 28.71±0.33; 6%, 24.23±0.33; 9%, 21.73±0.33). We conclude that the changes in the light absorbance of the resistance media are an expression of the sperm mobility. Moreover, this technique has a potential application, under field conditions, to assess objectively sperm mobility and categorize males based on a Sperm Mobility Index.

Key Words: Sperm, Boar, Mobility

W213 In vitro production of Holstein embryos using Beltsville method sex-sorted sperm. R. D. Wilson*¹, K. A. Weigel¹, P. M. Fricke¹, M. L. Leibfried-Rutledge², D. L. Matthews¹, J. J. Rutledge^{1,2}, and V. R. Schutzkus¹, ¹University of Wisconsin Madison, ²BOMED Inc, Madison, WI.

Our objective was to explore the impact of sperm sorting on the efficiency of in vitro embryo production in Holstein cattle. Cull cows were used as donors, and ovaries were collected via colpotomy or at the time of slaughter. Oocytes were aspirated from the ovaries, and embryos were produced using sex-sorted semen from three Holstein sires. Embryos were transferred into recipient Holstein cows and heifers on the donors farm. Seven Wisconsin herds participated, and 365 embryos were produced from 104 donor cows. Only 272 were transferred, due to limited availability of recipients. On average, 3.5 ± 0.4 transferable embryos were produced per donor, including 1.4 ± 0.2 grade one embryos and 1.5 ± 0.2 grade two embryos. Individual farms averaged from 1.6 to 5.8 transferable embryos per donor. On average 43.7 ± 4 oocytes were collected per donor. The number of usable oocytes averaged 33.9 ± 3.4 and percent embryo cleavage (52.1 ± 1.9) were significant predictors of the number of blastocysts and number of transferable embryos. Preliminary pregnancy results show strong farm and sire effects. Overall conception rate was 36 percent for heifer recipients and 18 percent for milking cow recipients (P<.05). To test the effect of sperm sorting on the percentage of embryos developing to blastocyst stage, oocytes were recovered from anonymous donors at a slaughterhouse and fertilized using non-sorted sperm or sex-sorted sperm from these sires. Oocytes (n=3312) fertilized using non-sorted sperm produced (P<.05) more embryos developing to blastocysts than oocytes (n=1577) fertilized using sex-sorted sperm (20.1 ± 2.9 percent vs. 12.2 ± 2.3 percent, respectively). These results suggest that sexing sperm using the Beltsville method (fluorescence-activated cell sorting) method may have adverse effects on embryo development and conception rates in in vitro production systems.

Key Words: Sexed Semen, In Vitro Production, Dairy Cattle

W214 Induction of bilateral double ovulation to promote twinning in beef cattle. M. Hogue¹, A. Bor², Y. Lavon¹, M. Maman¹, S. Jacoby², and D. Wolfenson*¹, ¹The Hebrew University, Rehovot, Israel, ²Agricultural Research Organization, Bet Dagan, Israel.

Beef cattle producers gain substantial economic benefits from cows that produce twins. Calf survival and birth weight are greater and incidences of abortion and dystocia are less in bilateral than unilateral twin pregnancies. A major objection to using gonadotropins to induce twins is the wide variation of ovarian response. The present study examined induction of bilateral-double or triple ovulation by stimulating follicle

growth with FSH, use of ultrasound-guided selective follicular aspiration to remove extra-large follicles, followed by supportive FSH to maintain co-dominance. In Exp. 1, Holstein cows were given short (three doses, n=6) or long (five doses, n=6) FSH treatment (50 mg Folltropin) every 12 h, from day (d) 3 of the cycle. On d 5, selective aspiration was performed, on d 6, PGF_{2α} was given, on d 7, two supportive 30 mg doses of FSH were given 12 h apart to maintain co-dominance, on d 8, GnRH was given and post-ovulation CL growth was determined. Short and long FSH treatments induced double or triple ovulation in 42% of the cows. In Exp. 2, a short FSH treatment was given only to cows (n=10) with 7 to 8 mm medium follicles on d 3, and supportive FSH (30 mg) was given on d 5 and 6. Two non-responding cows were excluded, and 6 out of 8 cows (75%) exhibited double or triple ovulation. Control cows (n=6) that did not receive FSH ovulated a single follicle, as expected. In Exp. 3, on Holstein heifers, 4 heifers with no supportive FSH doses ovulated a single follicle, and 50% of those that received 10 mg on d 5, 6 and 7 (n=5) or 30 mg on d 5 and 6 (n=5) exhibited double or triple ovulations. Overall for Exps 1-3: 3.0 medium and 1.8 large follicles were counted on d 4, 2.5 follicles were aspirated on d 5, and 70% of the cows exhibited bilateral ovulations. The results suggest that FSH combined with selective follicular aspiration can be used to induce bilateral twinning in beef cattle.

Key Words: Twins, Double Ovulation, Beef Cattle

W215 Effects of holding time prior to freezing on the motility, viability and membrane binding ability of ram sperm. P. H. Purdy*, *USDA-ARS-National Animal Germplasm Program, Fort Collins, CO.*

The United States sheep industry lacks infrastructure to effectively collect and store genetic resources in the national repository. Therefore, we investigated a methodology that could be used to ship diluted ram semen samples that were cooled and held at 5°C for up to 48 hours prior to cryopreservation. Semen samples from 6 rams were collected and the concentration and motility were determined using spectrophotometry and computerized automated semen analysis (CASA), respectively. Samples were diluted to 400 x 10⁶ cells per mL with a one-step Tris-egg yolk-glycerol media and cooled to 5°C over 2 hours using a styrofoam shipping box and commercial cold packs. The samples were maintained at 5°C in the shipping box, and aliquots were loaded into 0.5 mL French straws at 0, 24 or 48 hours after cooling, frozen in vapor 4.5 cm above liquid nitrogen for 12 to 13 minutes and plunged for storage. No differences between freeze times (0, 24, 48 h) were detected using ANOVA in post thaw motility (29, 31, 36%; P > 0.05), plasma membrane integrity (28, 35, 29%; P > 0.05) or live acrosomal integrity (99, 99, 99%; P > 0.05). Motility was assessed using CASA, and plasma membrane integrity and acrosomal integrity were simultaneously determined using the fluorescent stains propidium iodide and FITC-PNA, respectively, with flow cytometry. In addition, no differences were observed in the mean number of cells binding to a chicken oocyte membrane (461, 532, 319; P > 0.05) at time 0, 24 and 48 h, respectively. These results indicate that ram sperm may be held at 5°C for up to 48 hours prior to freezing with no deleterious effects on post thaw motility, plasma membrane integrity and acrosomal integrity. In addition, the chicken oocyte membrane binding assay demonstrates a simple in vitro method to assess post-thaw ram sperm capacitation, acrosome reaction and binding ability. The combination of the shipping protocol and viability testing has the potential to ease the constraint on collecting and freezing ram semen.

Key Words: Ram Spermatozoa, Cryopreservation, Capacitation and Acrosome Reaction

W216 Effects of PGF presynchronization and CIDR on pregnancy rates in suckled beef cattle subjected to fixed-time insemination following estradiol and progesterone treatment to synchronize follicular growth, and PGF and estradiol cypionate treatment to synchronize ovulation. J. A. Small*¹, M. G. Colazo², J. P. Kastelic³, and R. J. Mapletoft². ¹*Agriculture and Agri-Food Canada, Brandon, Manitoba*, ²*WCVM-University of Saskatchewan, Saskatoon, Canada*, ³*Agriculture and Agri-Food Canada, Lethbridge, Alberta.*

The objective was to determine effects of presynchronization and controlled-release progesterone on pregnancy rate in beef cattle subjected to a synchronization program based on estradiol, progesterone

(P4) and PGF treatment for AI without estrus detection (TAI). Cross-bred suckled beef cattle (n = 288) at 47 ± 14.8 d (mean ± standard deviation) post-partum were allocated to three treatment groups on the basis of parity (n=78, 66, 41, and 79 for Lactations 1, 2, 3 to 4 and 5 to 10, respectively), body weight (range 416 to 842 kg), and body condition score (range 3.5 to 6.0). All cattle were treated with 2.5 mg estradiol-17β and 100 mg progesterone (P4; both from Sigma Chemical Co, St. Louis, MO) im on Day 0 and 500 ug cloprostenol sodium (PGF; Estrumate, Schering-Plough, Pointe Claire, QC) and 0.5 mg estradiol cypionate (ECP; Professional Veterinary Laboratories, Winnipeg, MB) im on Day 7, with AI 56 h later (TAI Day 9.3). Experimental treatments were CIDR (1.9 g P4; Bioniche Animal Health, Belleville, ON) for 7 d on Day 0 (Groups 1 and 3), and PGF on Day -7 (Groups 2 and 3). All AI utilized frozen-thawed semen with proven fertility. From Days 11 to 54, the cattle were exposed to fertile bulls and frequently observed for estrus and breeding. Pregnancy was diagnosed by ultrasonography (Day 54) and transrectal palpation (Day 129). There was no interaction of parity and treatment (P>0.05). Pregnancy rate to TAI was lowest (P<0.05) for Group 2 (46.9, 31.2, and 45.3% for Groups 1, 2 and 3, respectively). Pregnancy rate to natural service was greatest (P<0.05) for Group 2 (46.9, 64.6 and 45.3%); most breedings occurred from 17 to 24 d after TAI (85.2, 59.1, and 72.4%; P>0.05). Cumulative pregnancy rates were similar (P>0.05) among groups (93.8, 95.8 and 90.6%). Pregnancy rate to TAI was significantly increased with a CIDR, but was not significantly affected by PGF presynchronization.

Key Words: Estrus Synchronization, Fixed-Time AI, Beef Cattle

W217 Effect of presynchronization with GnRH on fertility of holstein dairy heifers receiving synchronization of ovulation and timed artificial insemination (TAI). H. Rivera* and P. M. Fricke, *University of Wisconsin, Madison.*

To evaluate the effect of presynchronization with GnRH on the response of heifers receiving a hormonal protocol for synchronization of ovulation and TAI, Holstein dairy heifers (n=166) 14.9 ± 0.2 mo of age were randomly assigned to each of two treatments. Heifers (n=82) in the first treatment (GPG) received a hormonal protocol for synchronization of ovulation and TAI (100 µg GnRH, d 0; 25 mg PGF_{2α}, d 6; 100 µg GnRH+TAI, d 8), whereas heifers (n=84) in the second treatment (GGPG) received the same treatment as GPG heifers but with the addition of 100 µg GnRH 7 d before the first GnRH injection of the protocol (d -7). Artificial insemination before scheduled TAI on d 8 was conducted for heifers in both treatments based on once daily assessment of removed tail chalk beginning on d 0. Although presynchronization increased (P<0.05) the proportion of heifers with ≥ 2 CL on d 0 (30% 25/84 vs. 5% 4/81), the proportion of heifers ovulating after the first GnRH injection on d 0 (39%, 31/80 vs. 40%, 32/80), the proportion of heifers undergoing luteal regression after PGF_{2α} on d 6 (89%, 58/65 vs. 94%, 64/68), the proportion of heifers ovulating after the second GnRH injection on d 8 (87%, 66/76 vs. 85%, 66/78), the proportion of heifers receiving AI before TAI (9.5%, 8/84 vs. 4.9%, 4/82), and conception rate 30 d after AI (51%, 43/84 vs. 45%, 37/82) did not differ between GGPG vs. GPG heifers, respectively. Serum progesterone (P4) concentration on d 0 was greater (P<0.05) for heifers with > 1 CL (3.9 ng/ml) compared to heifers with one CL (2.8 ng/ml); however, serum P4 did not differ at the PGF_{2α} injection on d 6 based on CL number (3.8 vs 3.6 ng/ml). In conclusion, presynchronization with GnRH 7 d before initiation of synchronization of ovulation using GnRH and PGF_{2α} failed to decrease the proportion of heifers expressing estrus during the protocol and did not improve synchronization response or fertility to the protocol. *Supported by Hatch project WIS04431 to PMF*

Key Words: Dairy Heifers, Synchronization of Ovulation, Timed Artificial Insemination

W218 Effect of termination of pregnancy on serum concentrations of pregnancy associated glycoproteins in beef cows. D. C. Busch*, J. A. Atkins, D. J. Schafer, J. F. Bader, D. J. Patterson, T. E. Parks, J. A. Green, and M. F. Smith, *University of Missouri, Animal Science Research Center, Columbia.*

Pregnancy associated glycoproteins (PAGs) are produced by binucleate cells in the ruminant placenta and have been used to diagnose pregnancy in cattle from d 27 post insemination to term. Previous studies indicate that PAGs have a half-life of approximately 8 d following calving; however, we hypothesized that the half-life would be shorter during early

gestation. The objective was to determine the half-life of bovine PAGs following prostaglandin $F_{2\alpha}$ (PGF)-induced abortion on d 32 to 36 post insemination. Twenty-five crossbred cows were artificially inseminated and allotted to a control (n = 10) or PGF (n = 15) group by age, breed, and days post AI. Blood samples were collected, via venipuncture, from cows every other day from approximately d 20 (d 0 = estrus) to d 28 post AI, daily from d 29 to PGF injection, and every 8 h from PGF injection until serum concentrations of PAGs decreased below the pregnancy-detection threshold of the assay. The uteri of all cows were examined by transrectal ultrasonography at d 30 and at the time of each blood sample following PGF injection to determine the time the fetal heartbeat stopped and when the embryo was expelled from the uterus. Serum concentrations of PAGs were determined by ELISA and were first detected between d 24 and 28 post AI. Serum concentrations of PAGs increased similarly in the control and PGF groups from d 28 to the time of PGF injection. Following PGF treatment (0 h), serum concentrations of PAGs decreased ($P < 0.05$) by 32 h and remained low through 144 h. The half-life of PAGs (mean \pm SD) following PGF treatment was 59.7 \pm 36.4 h (range 32 to 180 h). Interval (mean \pm SD) from PGF injection to loss of fetal heartbeat, loss of embryo, and estrus was 50.5 \pm 9.3 h, 60.7 \pm 10.1 h, and 97.1 \pm 12.1 h, respectively. In summary, the half-life of PAGs (d 32 to 40) was determined to be 2.5 d and may provide an alternative method to transrectal ultrasonography for monitoring late embryonic/fetal mortality.

Key Words: Pregnancy, Prostaglandin, Beef Cattle

W219 Use of supplemental GnRH following timed-insemination on pregnancy rates in dairy cattle exposed to mild heat stress or cool season environments. T. Dickerson*, K. Graves, J. White, S. Bowers, A. Denson, S. Schmidt, and S. Willard, *Mississippi State University, Mississippi State.*

Reproductive efficiency in dairy cattle decreases when animals are exposed to heat-stress conditions. Studies were conducted in the summer and fall seasons of 2003 to evaluate the efficacy of supplemental GnRH injections post-breeding on pregnancy rates in lactating dairy cattle. Lactating dairy cows in Summer (n=44) and Fall (n=74) were synchronized using the Ovsynch protocol, bred (TAI), and assigned to one of three GnRH treatment groups: Control (CON; no GnRH post-TAI), GnRH on d 5 & 11 post-TAI (GnRH-5/11), or GnRH on d 5 post-TAI (GnRH-5). Blood samples were collected on specified days throughout each trial for evaluation of serum concentrations of progesterone (P4). Ultrasonography was performed on d 5, 11, and 17 post-TAI on a subset of cows (n=8/treatment) for both studies for determination of CL area and number. Ambient temperature and relative humidity were collected daily at 10 min intervals for calculation of temperature-humidity index (THI). Overall Summer THI (24-h) was 77 (mild heat stress). No differences ($P > 0.10$) were observed for serum concentrations of P4, CL area, and CL number with respect to treatment. Pregnancy rates for CON, GnRH-5/11, and GnRH-5 were 7.0%, 20% and 29% respectively with no differences ($P > 0.10$) relative to treatment. Retrospective analysis of P4, and removal of cows (n=11) failing to respond to Ovsynch, resulted in an adjusted pregnancy rate of 13%, 23% and 33 %, respectively. Fall THI (24-h) was 52 (no heat stress). On D14 post-TAI, GnRH-5/11 cows had higher ($P < 0.05$) serum P4 than CON, but did not differ ($P > 0.10$) from GnRH-5 cows. On D17 post-TAI, GnRH-5/11 cows had higher ($P < 0.05$) CL numbers than either CON or GnRH-5 cows. CL area was greater ($P < 0.05$) for GnRH-5/11 than CON cows, but did not differ ($P > 0.10$) from GnRH-5 cows on D17 post-TAI. Pregnancy rates for CON, GnRH-5/11, and GnRH-5 were 33%, 19% and 33% respectively, with no treatment differences ($P > 0.10$). In summary, supplemental GnRH influenced reproductive function (P4, CL number and area) in Fall cows (GnRH 5/11 group). However, overall pregnancy rates were not significantly improved by GnRH treatment in Summer or Fall.

Key Words: GnRH, Progesterone, Pregnancy

W220 Effect of prolonged in vivo incubation of sperm from high and low fertility bulls on pregnancy survival in lactating dairy cows. M. W. Macfarlane*, B. J. Macfarlane*, and J. R. Pursley, *Michigan State University, East Lansing.*

Fertility of lactating dairy cows is altered by timing of AI in relation to ovulation. However, it is not clear how bull fertility affects this relationship. This study was designed to determine the effect of prolonged in

vivo incubation of sperm from high and low fertility bulls on pregnancy rates and pregnancy survival in lactating dairy cows. All cows (n = 907) received Ovsynch to precisely control ovulation. Cows were inseminated at either 8 h prior to (treated), or 16 h after (control), the final injection of GnRH of Ovsynch. Therefore, treated and control cows received AI approximately 36 and 12 h prior to ovulation, respectively. Based on ultrasound examinations, only cows with synchronized ovulations were used in the study. Cows were assigned to treatments based on parity and days in milk (DIM). Bulls (n=5) were selected based on estimated relative conception rate (ERCR: + 4 or -4) and were assigned equally to cows in each treatment by parity and DIM. Ultrasonography was used to diagnose pregnancy at 28 and 56 d after AI. Outcomes were pregnancy rate / AI (PR/AI; %) at, and pregnancy survival (%) between, 28 and 56 d post-AI. Semen (n = 5 straws per bull) was randomly chosen and evaluated post-thaw for numbers of live sperm and percent motility. There was an effect of bull on PR/AI at ($P < 0.01$), and pregnancy survival between ($P < 0.01$), 28 and 56 d post-AI. PR/AI (%) and pregnancy survival (%) was decreased in the bull with the lowest overall fertility in treated vs. controls (10 vs. 25 and 58 vs. 86, respectively), but was not affected in the bull with the highest overall fertility (45 vs. 44 and 91 vs 98, respectively). Numbers of live sperm per straw, percent motility, and total live motile sperm were different between bulls ($P < 0.01$). There were strong correlations between PR/AI and pregnancy survival ($R = 0.68$) and % motility and PR/AI ($R=0.71$). In summary, prolonged in vivo incubation of sperm prior to ovulation appears to have a negative impact in low but not high fertility bulls. It appears that pregnancy losses may be predetermined at the time of fertilization.

Key Words: Dairy, Fertility, Timing of AI

W221 Synchronization of beef heifers using CIDR with estradiol cypionate. D. M. Kniffen*¹, B. M. Neely¹, P. R. Tozer², and M. L. O'Connor¹, ¹*Penn State University, University Park*, ²*Western Australian Department of Agriculture, Geraldton, WA.*

Improving the success rate of estrous synchronization programs may increase the use of artificial insemination (AI) in the beef industry. The time and effort required to detect estrus in beef females continues to be a roadblock to increased use of AI. Introduction of an intravaginal progesterone insert (CIDR) has provided an effective method of estrous synchronization. Improving the synchrony of estrus following CIDR removal without sacrificing fertility will further reduce the time commitment for an effective AI program. The objective of this study was to determine if synchrony of estrus following a CIDR protocol could be enhanced by administration of 2 mg estradiol cypionate (ECP) at CIDR insertion. Seventy Angus and Angus-based crossbred beef heifers of breeding age and weight received a CIDR device on d 0. On d 7, the CIDR was removed and PGF₂ α (25 mg) was administered. The treatment group (n=35) received ECP. Heifers were observed for estrus for 30 min at 2 h intervals for 72 h following CIDR removal. All heifers were inseminated by a professional technician soon after observed in estrus, generally within 12 h. The percentage of heifers observed in estrus within 72 h did not differ ($P > 0.10$) between treatment (74%) and control (71%) groups. First service conception rates (49%) did not differ ($P > 0.10$). However, the average interval to onset of estrus following CIDR removal differed ($P < 0.05$; 45 h for treated vs 51 h for controls). ECP induced an earlier expression of estrus without affecting conception rate.

Key Words: Synchronization, Heifers, CIDR

W222 Synchronization of estrus in suckled beef cows using GnRH, prostaglandin $F_{2\alpha}$ (PG), and progesterone (CIDR): a multi location study. J. E. Larson*¹, G. C. Lamb¹, J. S. Stevenson², S. K. Johnson², M. L. Day³, T. W. Geary⁴, D. J. Kesler⁵, J. M. DeJarnette⁶, F. N. Schrick⁷, and J. D. Arseneau⁸, ¹*University of Minnesota, St. Paul*, ²*Kansas State University, Manhattan*, ³*The Ohio State University, Columbus*, ⁴*USDA-ARS*, ⁵*University of Illinois, Urbana*, ⁶*Select Sires, Inc.*, ⁷*University of Tennessee, Knoxville*, ⁸*Purdue University, West Lafayette, IN.*

We determined whether a fixed-time AI (TAI) protocol could yield similar pregnancy rates to a protocol requiring detection of estrus and if adding a CIDR to GnRH + PG-based protocols would enhance fertility. Estrus in 2,630 suckled beef cows from 14 locations was synchronized and artificial insemination occurred after five treatments: 1) a CIDR for 7 d with 25 mg of PG at CIDR removal, followed by detection of estrus and AI for 84 h with any cow not detected in estrus by 84 h receiving

100 µg of GnRH and TAI at 84 h (Control; n = 511); 2) GnRH, followed in 7 d with PG, followed in 60 h by a second injection of GnRH and TAI (CO-Synch; n = 551); 3) CO-Synch plus a CIDR during the 7 d between the first injection of GnRH and PG (CO-Synch+CIDR; n = 547); 4) GnRH, followed in 7 d with PG, followed by detection of estrus and AI for 84 h, with any cow not detected in estrus by 84 h receiving GnRH and TAI at 84 h (Hybrid Synch; n = 513); and, 5) Hybrid Synch plus a CIDR during the 7 d between the first injection of GnRH and PG (Hybrid Synch+CIDR; n = 508). Pregnancy was diagnosed by transrectal ultrasonography and blood samples were collected (d -17 and -7, relative to PG) to determine cycling status. The percentage of cows cycling at the initiation of estrus synchronization was 67%. Pregnancy rates among locations ranged from 39% to 67%. Pregnancy rates were greatest for the Hybrid Synch+CIDR (57.9%) treatment, although not different from the CO-Synch+CIDR (53.6%) and Hybrid Synch (53.0%) treatments, but greater ($P < 0.05$) than the Control (52.3%) and CO-Synch (43.4%) treatments. Controls did not differ from CO-Synch+CIDR or Hybrid Synch. Overall, the Hybrid Synch+CIDR protocol consistently achieved the greatest pregnancy rates; however, CO-Synch+CIDR was a reliable TAI protocol that gives producers the option to eliminate detection of estrus when inseminating beef cows.

Key Words: Estrus Synchronization, Artificial Insemination, Beef Cows

W223 Synchronization of estrus in replacement beef heifers using GnRH, prostaglandin F_{2α} (PG), and progesterone (CIDR): a multi-location study. J. E. Larson^{*1}, G. C. Lamb¹, T. W. Geary², J. S. Stevenson³, S. K. Johnson³, M. L. Day⁴, D. J. Kesler⁵, J. M. DeJarnette⁶, and D. G. Landblom⁷, ¹University of Minnesota, St. Paul, ²USDA-ARS, ³Kansas State University, Manhattan, ⁴The Ohio State University, Columbus, ⁵University of Illinois, Urbana, ⁶Select Sires, Inc., ⁷North Dakota State University, Fargo.

Our objectives were to determine whether a fixed-time insemination (TAI) protocol could yield similar pregnancy rates to a protocol requiring detection of estrus (EAI) and whether an injection of GnRH at CIDR insertion enhanced fertility. Estrus in 2,077 replacement beef heifers from 12 locations was synchronized and AI occurred after four treatments: 1) a CIDR for 7 d with 25 mg of PG on the day of CIDR removal, followed by detection of estrus and AI during 84 h. Heifers not detected in estrus by 84 h received 100 µg of GnRH and were inseminated (EAI; n = 517); 2) heifers were treated and inseminated as EAI heifers but also received GnRH at the time of CIDR insertion (GnRH+EAI; n = 504); 3) heifers received a CIDR for 7 d with PG on the day of CIDR removal, followed in 60 h by a second injection of GnRH and TAI (TAI; n = 531); and 4) heifers were treated and inseminated as TAI heifers but also received GnRH at CIDR insertion (GnRH+TAI; n = 525). Pregnancy was diagnosed by transrectal ultrasonography on d 30 to 35 and blood samples were collected (d 17 and 7, relative to PG) to determine cycling status. Percentage of heifers cycling at initiation of estrus synchronization was 91%, but the percentage of heifers cycling among locations ranged from 78 to 100%. Overall pregnancy rates among locations ranged from 38 to 74%. Pregnancy rates were 57.3, 54.5, 53.1, and 49.1% for GnRH+EAI, EAI, GnRH+TAI, and TAI, respectively. Although no differences in pregnancy rates among treatments were observed, the GnRH+EAI treatment most consistently achieved the greatest pregnancy rates. In addition, the GnRH+TAI protocol provides an alternative to estrus synchronize heifers with TAI as an option without detection of estrus.

Key Words: Estrus Synchronization, Artificial Insemination, Beef Heifers

W224 Ovulatory and reproductive characteristics of sows treated with an intravaginal GnRH agonist gel. K. Roski^{*1}, W. Flowers¹, G. B. Rampack², D. L. Gregor³, M. Swanson³, and H. D. Hafs³, ¹North Carolina State University, Raleigh, ²University of Georgia, Athens, ³EIEICO, Inc, Radnor, PA.

This study was designed to test the ovulatory and reproductive characteristics of sows treated with Ovugel (EIEICO, Radnor, PA), a gel containing a GnRH agonist administered intravaginally. The treatment groups received 100µg of GnRH agonist in varying viscosities of the gel, 0.6% (n=12), 0.9% (n=12), 1.2% (n=12), and 1.5% (n=12) respectively. A positive control group (n=11) received the 100µg of agonist in saline while the control sows received a vehicle of the 1.2% gel at 96h post weaning. Jugular cannulas were placed 48h before administration of the treatment. Blood samples were taken every 6h before treatment,

then every 2h for the first 12h after treatment, then every 6h for the next 18h. Estrus detection occurred every 6h through the entire study as well as real time ultrasonography every 4h to determine the time of ovulation. Control sows were bred based on the onset of estrus (n=9) and treatment sows were bred at +8 and +32h after the gel was administered. There were no differences in treatments in ovulation time (p=0.28), estrus length (p=0.60), farrowing rate (p=0.80), litter size (p=0.35), or LH surge (p=0.49). However, variation associated with ovulation time was significantly reduced (p=0.01) for saline, 1.2%, and 1.5% treatments compared with controls. The intravaginal absorption of GnRH in Ovugel or saline along with a timed insemination program is an effective method to reduce the interval over which ovulation occurs without overtly decreasing fertility.

Treatment	Saline + GnRH	Control	0.6% + GnRH	0.9% + GnRH	1.2% + GnRH	1.5% + GnRH
Ovulation Time (h)	46.5 ±1.2	43.8 ±5.4	43.8 ±2.0	41.2 ±3.3	43.5 ±1.8	44.5 ±1.5
Estrus Length (h)	45.8 ±3.4	45.6 ±3.8	49.0 ±3.8	47 ±3.9	46.9 ±3.9	55.1 ±3.9
LH Surge (0-30h post treatment)	7/10	5/8	7/10	9/11	8/10	8/9
Farrowing Rate	8/8	9/9	11/12	10/12	11/12	10/11
Litter Size	12.9 ±0.7	9 ±1.2	11 ±1.3	11.6 ±1.0	11 ±0.5	10.6 ±1.4

Key Words: Ovulation, GnRH Agonist, Swine

W225 The effects of estradiol cypionate on expression of estrus in a follicular synchronization program. B. Dixon^{*}, D. L. Ray, T. B. Hatler, and W. J. Silvia, Department of Animal Science, University of Kentucky, Lexington.

The objective of this experiment was to determine the effect of estradiol cypionate (ECP) on expression of estrus when used in conjunction with a presynchronization and estrus synchronization program. Ninety lactating Holstein (n=66) and Jersey (n=24) cows in varying stages of lactation were given two injections of PGF_{2α} fourteen days apart to presynchronize luteolysis. Twelve days following the last PGF_{2α} injection, a follicular synchronization program was initiated with an injection of GnRH (100µg, Factrel, Fort Dodge Animal Health), followed seven days later by PGF_{2α} (25mg, Lutalyse, Pfizer). Half of the cows were then assigned to receive an injection of ECP (1mg, Pfizer) 24 hours after the last PGF_{2α} injection. The other half received no ECP. Venous blood samples were collected three times per week for three weeks during the final phase of the synchronization for determination of progesterone levels. These samples were used to monitor luteolysis and formation of a new corpus luteum. Presynchronization failed to adequately synchronize the cycle of 31 out of 90 cows. ECP had a significant effect on expression of estrus among cows that were successfully presynchronized and ovulated. Of those cows that were properly synchronized for breeding, 100% (28/28) of cows treated with ECP expressed estrus, while only 81.8% (18/22) of untreated animals did so (P=.0318). For animals that fully regressed their corpus luteum and ovulated, expression of estrus was more tightly synchronized among cows receiving ECP (90.3% (28/31) expressing heat between 29 and 53 hours post ECP) than those that did not (53.9% (14/26)) (P=.0025). Of the 46 cows that appeared endocrinologically normal, expressed estrus and were bred, 15 conceived (32.6%). ECP had no effect on conception rate. The postovulatory rise in progesterone appears to be slower in nonpregnant animals than pregnant animals, with pregnant cows reaching progesterone levels 1.0 ng/mL higher 12 days after the final PGF_{2α} than animals that failed to conceive (P=.01). In conclusion, the addition of ECP to a synchronization program improves expression of estrus among cows that were successfully synchronized for breeding.

Key Words: Synchronization, ECP, Estrus Expression

W226 Influence of milk production on conception following artificial insemination or embryo transfer in lactating Holstein cows. D. G. B. Demetrio^{*1}, J. L. M. Vasconcelos¹, C. A. Rodrigues², and J. R. Chiari², ¹FMVZ-UNESP, ²Samvet Clínica e Embrios, Brazil.

The aim of this trial was to evaluate conception following artificial insemination (AI) or embryo transfer (ET) in lactating Holstein cows. The trial was conducted at a dairy farm located in Descalvado, Sao Paulo, Brazil from October to December of 2003. Cycling cows (n=251) producing 33.5±7.2 kg milk/d with 174.4±116.2 DIM received PGF2α (Lutalyse[®], 25 mg, i.m.) and were assigned to two groups. Cows detected in estrus between 48 and 96h after PGF2α injection (n=106) were divided into: G1 (n=57); AI 12h after heat detection, or G2 (n=49); ET 6 to 8 d after detection of estrus. All cows from G2 received fresh embryos (grade 1 or 2) that were transferred by one trained technician. Milk production was measured daily, and the average of 7 d of production was used for analysis (starting on the day of the estrous detection). Pregnancy was detected 25 to 32 d after estrous detection by ultrasonography (Aloka SSD-500). Data were analyzed by a general linear models (GLM) procedure. Variables included in the model were milk production, previous number of AI, DIM, body temperature at d 7 and interactions. Conception was affected by treatment (P=0.07) and the adjusted results were 31.6±10.1% in G1 (IA) and 54.4±9.6% in G2 (TE). An interaction between milk production and treatment was detected (P<0.05). Cows with milk production under the average (33.5 kg milk/d) had similar conception rates: 49.1±14.1% (n=26) in G1 (IA) and 40.1±13.6% (n= 24) in G2 (TE). Cows over the average had different conception rates: 14.0±14.1% (n= 31) in G1 (IA) and 68.7±16.7% (n= 25) in G2 (TE). Variables included in the model: previous number of AI, DIM and body temperature at d 7 did not affect conception, but milk production had adverse influence on AI conception rate, but not on ET. This study suggests that embryo transfer can be used as a tool to increase conception rate in high milk production cows, rather than only on repeat breeder cows. This data also shows that milk production effects on conception could occur during the 7 d after ovulation.

Key Words: Embryo Transfer, Artificial Insemination, Milk Production

W227 Follicular diameter in postpartum Nellore cows treated with CRESTAR protocol. G. C. Perez^{*}, R. M. Santos, J. L. M. Vasconcelos, E. T. N. Pereira, and D. B. Araujo, DPEA-FMVZ-UNESP, Botucatu, SP, Brazil.

The CRESTAR[®] protocol consists of a 9-d ear implant (3mg of norgestomet) combined with injection of estradiol valerate (5mg) and norgestomet (3mg) at the time of implant insertion. The objective of this study was to evaluate if body condition score (BCS), parity and cyclicity affects follicular diameter at the time of implant removal. Nellore cows (n = 415) averaging 119 ± 39.7 d postpartum, and with a BCS between 2.25 to 3.50 (1 to 5 scale), were maintained on pasture (*Brachiaria decumbens*) with mineral provided ad libitum. Ovarian structures were evaluated by transrectal ultrasonography using a B-mode scanner with a 7.5 MHz linear array transducer (Aloka SSD-500, Wallingford, CT). Cyclicity was determined before the beginning of the protocol by two ultrasound examinations 10 d apart. Cows showing luteal tissue at one of the exams were considered to be cycling. Follicular diameter and BCS were evaluated at the time of implant removal. Data were analyzed by a general linear models (GLM) procedure, and the variables included in the model were BCS, cyclicity, and parity. BCS influenced (P<0.05) follicular diameter at the time of the implant removal: 2.5 (8.9 ± 0.28mm; n = 78); 2.75 (9.5 ± 0.22mm; n = 137); 3.0 (9.5 ± 0.25mm; n = 109); 3.25 (10.2 ± 0.34mm; n = 55); 3.5 (9.7 ± 0.42mm; n = 36). Follicular diameter was not affected by parity [9.4 ± 0.27 mm in primiparous cows (n=87) vs 9.7 ± 0.14 mm in multiparous cows (n=328)] nor by cyclicity [9.7 ± 0.20mm in anestrus cows (n=201) vs 9.4 ± 0.20mm in cycling cows (n=214)]. Cows with lower BCS had smaller follicular diameter at the time of implant removal. Mechanisms controlling this phenomenon may be related to the injection of estradiol valerate which could delay the emergence of a new follicular wave by suppressing FSH or LH secretion and cause turnover of the dominant follicle in thin cows. Data suggest that cows with a low BCS may require a longer ear implant period and/or a smaller dose of estradiol valerate at the beginning of the CRESTAR[®] protocol.

Key Words: CRESTAR, Follicular Diameter, Nellore Cows

W228 Serum progesterone concentrations in Nellore x Angus heifers treated with 1.38-g or 1.9-g CIDR devices. R. M. Santos^{*1}, J. L. M. Vasconcelos², G. C. Perez², A. B. B. Maciel², and O. G. Sa Filho², ¹FCAV-UNESP, Jaboticabal, SP, Brazil, ²FMVZ-UNESP, Botucatu, Brazil.

The aim of this study was to determine serum concentrations of progesterone (P4) during treatment with intravaginal devices containing either 1.38 g or 1.9 g of P4 for 25 d. Estrous cycles of Nellore x Angus heifers (n=26) were presynchronized using a modified Ovsynch protocol (GnRH - 50µg - 6d - PGF2α - 25mg - 48h GnRH - 50µg). Seven days after the second injection of GnRH, synchronized heifers (n=18) received PGF2α and 24 h later were assigned to either G1 (n=9; CIDR[®] 1.38 g) or G2 (n=9 CIDR[®] 1.9 g). Only heifers that had a regressed CL (determined by P4 concentrations on d 6, 7, 7.5 and 8) were used (5 heifers in G1 and 7 in G2). Serum P4 concentrations were quantified by RIA. Peak concentrations of P4 were evaluated at 0, 1, 4, 8 and 12 h after CIDR insertion, and every other day for 25 d. The decline in concentrations of P4 d was evaluated at 0, 1, 4 and 8 h after CIDR removal. Data were analyzed by a general linear models (GLM) procedure. Two cows from G2 lost the CIDR (at d 8 and 25, respectively) and were excluded from the analysis. Serum concentrations of P4 peaked within 1 h after device insertion, with peak concentrations higher (P<0.05) for G1 (10.2±1.21ng/mL) than for G2 (6.8±1.02ng/mL). Within 4 h concentrations of P4 were similar for G1 (6.3±0.64ng/mL) and for G2 (6.0±0.54ng/mL) and thereafter through d 25. Concentrations of P4 ranged from 2-3 ng/mL between d 1 and 8 for G1 and until day 11 for G2, and then from 1-2 ng/mL until the day of insert removal. On d 25, mean concentrations were 1.02±0.12ng/mL and 1.12±0.12ng/mL for G1 and G2, respectively. The decrease in P4 concentrations after insert removal was similar between groups. One hour after insert removal, P4 concentrations were 0.3±0.04ng/mL and 0.2±0.04ng/mL in G1 and G2, respectively. Although the 1.38-g CIDR produced a lower overall serum P4 concentration, the peak in P4 concentrations 1 h after CIDR insertion was higher than for the 1.9-G CIDR. This might be important in synchronization protocols, as rapid changes in circulating concentrations of P4 could affect LH pulsatility and turnover of the dominant follicle.

Key Words: CIDR, Progesterone, Beef Heifers

W229 Prolonged in vivo incubation of sperm affects fertility of lactating dairy cows and gender ratio of resulting offspring. M. W. Macfarlane^{*}, B. J. Macfarlane^{*}, and J. R. Pursley, Michigan State University, East Lansing.

The chance of a female calf being born is less than that of a male calf (female: male ratio of calves born is 46:54); and only 85% of female calves that are born successfully begin their first lactation. Therefore, increasing numbers of females available for herd replacement and marketing may increase sustainability and profitability of dairy enterprises. This study was designed to determine if prolonged in vivo incubation of sperm increases the percentage of female calves born. Lactating dairy cows (n=1606) from 3 farms received Ovsynch to precisely control ovulation. Cows were inseminated either in the uterine body or uterine horn ipsilateral to the ovary with the predicted pre-ovulatory follicle at either 8 h prior to (-8 group), or 16 h after (+16 group), the final injection of GnRH of Ovsynch (2 x 2 design). Therefore, cows in the -8 and +16 h groups received AI approximately 36 and 12 h prior to ovulation, respectively. Based on ultrasound examinations, only cows with synchronized ovulations were used in the study. Cows were assigned to treatments based on parity and days in milk (DIM). Ultrasonography was used to diagnose pregnancy at 28 and 56 d after AI. Outcomes were pregnancy rate/AI (PR/AI; %) at, and pregnancy survival (%) between, 28 and 56 d post-AI, and gender of resulting offspring. There was no effect of site of AI on PR/AI, so uterine body and uterine horn groups were combined within -8 and +16 groups. Overall, a greater % of female calves were born in the -8 h vs. +16 groups (55 vs. 45; P < 0.05). Farms 1 and 2, collectively, had greater (P < 0.05) % females born compared to farm 3 in both the -8 and +16 h groups (68 and 56 vs. 49 and 40, respectively). The +16 h group had a greater (P < 0.01) PR/AI (39 % vs. 29 %) than the -8 h group. Pregnancy survival (%) between 28 and 56 d post-AI was similar between 8 and +16 (80 vs. 83, respectively) but was greater in cows receiving uterine body vs. uterine horn AI (85 vs. 79, respectively). In summary, prolonged in vivo incubation of sperm

prior to ovulation appears to improve female:male ratio of calves born, but reduces fertility.

Key Words: Gender Ratio, Timing of AI, Pregnancy Rate

W230 Effect of eCG and/or calf removal after CRESTAR protocol in Nellore cows. G. C. Perez*, J. L. M. Vasconcelos, R. M. Santos, E. T. N. Pereira, and O. G. Sa Filho, DPEA-FMVZ-UNESP, Botucatu, SP, Brazil.

The CRESTAR[®] protocol consists of an ear implant (3mg norgestomet) for 9 days associated with an injection of estradiol valerate (5mg) and norgestomet (3mg) at implant insertion. The aim was to evaluate the effects of eCG injection at implant withdraw and/or calf removal (CR) between implant withdraw and TAI. Nellore cows (n=415) with 119±39.7 days postpartum (DPP), body condition score (BCS) between 2.25 to 3.5 (1-5) were assigned to 4 groups in 2x2 factorial (eCGxCR): G1(n=105) CRESTAR; G2(n=102) CRESTAR + CR (58h); G3(n=104) CRESTAR + eCG (Folligon[®], 400UI) at implant removal and G4(n=104) CRESTAR + eCG at implant removal + CR (58h). TAI was performed in the 4 groups 50-58 h after implant removal. Ovarian structures and pregnancy were evaluated by ultrasound (Aloka SSD-500). Cyclicity was determined before the beginning of the protocol by 2 ultrasound examinations 10 days apart. Follicular development was determined by the difference between the follicle diameter on day of AI and on implant removal. Data were analyzed by general linear models, and parameters included in the model were DPP, CR, eCG, BCS, cyclicity, parity, calf gender and interactions. Cows that received eCG had better follicular development (1.8±0.2 vs. 1.2±0.1mm; P<0.01), higher estrus detection before TAI (42.1 vs. 26.4%; P<0.01), and higher synchronization rate (75.3 vs. 64.5%; P<0.05) than cows that did not received eCG. Calf removal did not affect these parameters. Conception at TAI was not affected by eCG (53.6% in treated cows vs. 50.3% in not treated) and by CR (51.2 with CR vs. 52.7% without). Independent of the treatment, BCS did not affect synchronization rate but influenced (P<0.05) conception at TAI (2.25 59.4%; 36.2%; 2.5 68.2%; 44.1%; 2.75 71.8%; 45.9%; 3.0 77.7; 58.8%; 3.25 74.1%; 57.2%; 3.5 68.1; 69.3%) respectively. The data suggest that eCG treatment improves synchronization rate by keeping the follicular development between implant removal and TAI, but not conception at TAI probably due to the negative effects of BCS in conception are higher than positive effects of eCG treatment.

Key Words: CRESTAR, Synchronization, Nellore

W231 Assessment of pregnancy in the mare using digital infrared thermography. S. Bowers*, S. Gandy, B. Anderson, P. Ryan, and S. Willard, Mississippi State University, Mississippi State.

Digital infrared thermal imaging (DITI) is a non-invasive diagnostic technique that is used to detect symmetry and asymmetry in surface temperature gradients. The objective of this study was to investigate the use of DITI to determine whether temperature differences exist between pregnant and nonpregnant mares. On the day measurements were obtained, each pregnant mare (n=10; beginning at 292.4 ± 1.4 d of gestation) was paired with a nonpregnant mare (n=17). Mares were normalized to environmental conditions prior to imaging. Ambient (AMB) temperature, DITI measurements (left and right flank and wither temperatures and background temperature), and rectal temperatures (RT) were obtained every 7 d for 5 weeks before parturition. Measurements were obtained beginning in March and continued through May with AMB temperatures ranging from 4.2 °C to 28.9 °C. There were no differences (P>0.10) in temperature of the left and right side within group (pregnant vs. nonpregnant) therefore data were pooled within group for analysis. Background temperature was positively correlated with flank and wither temperature (R=0.48, R=0.58, respectively; P<0.01) and was positively correlated with AMB temperature (R=0.92; P<0.01). RT tended to be positively correlated with AMB temperatures (R=0.32; P<0.10) but were not correlated to flank or wither temperatures. Pregnant mares had a higher (P<0.01) flank temperature than the nonpregnant mares (36.0 ± 0.2°C vs. 34.2 ± 0.2°C, respectively). Moreover, the difference (2.4°C) in flank temperatures between the pregnant and nonpregnant mares was greater when the AMB temperature dropped below 19°C. Flank temperature and wither temperature were positively correlated with one another (R=0.72; P<0.01) and were positively correlated with AMB temperature (R=0.48, R=0.64, respectively; P<0.01). However, wither temperatures did not differ (P>0.10) between the pregnant

(33.9 ± 0.6°C) and nonpregnant mares (33.8 ± 0.3°C). In conclusion, pregnant mares had higher flank temperatures than nonpregnant mares regardless of environmental conditions. This suggests that DITI measurements may have value in detecting or confirming pregnancy (late gestation) in some species.

Key Words: Thermography, Equine, Pregnancy

W232 Optimizing sperm concentration to maximize monospermy and minimize polyspermy with bovine *in vitro* fertilization. M. Barcelo-Fimbres* and G. E. Seidel, Jr., Colorado State University, Ft Collins.

We evaluated sperm concentrations and times of fertilization for bovine IVF. Slaughterhouse oocytes were matured in a chemically defined medium (CDM) similar to SOF (J. Anim. Sci. 78:152) plus 0.5% fatty acid-free BSA and hormones (M-CDM) for 23 h, at 38.5°C in 5% CO₂ in air. Then oocytes and frozen-thawed sperm, centrifuged through a Percoll gradient, were co-cultured for 4 or 18h in F-CDM (CDM + heparin). Presumptive zygotes were cultured in CDM-1 (CDM + nonessential amino acids (NEAA), 0.5 mM glucose and 10 μM EDTA) at 38.5°C in 5%CO₂ /5%O₂ /90%N₂. After 5 h, half of the presumptive zygotes were fixed and stained with aceto-orcein to evaluate fertilization (FR) and polyspermy (PS). After 48h the rest were cultured 120h in CDM-2 (CDM + NEAA and essential amino acids and 2 mM glucose). Oocytes (N=960) were randomly allocated to a 2 x 3 x 4 factorial design: time of fertilization (4 and 18 h), sperm dose (1, 0.33, and 0.11 x 10⁶ sperm/mL), and sperm source (4 bulls). Percentages were arcsin transformed and analyzed by ANOVA. Respective main effect means for 1, 0.33, and 0.11 x 10⁶ sperm/mL were: FR (72%, 62% vs. 42%); cleavage (CR) (89%, 81% vs. 58%); PS (24%, 2% vs. 0%); and blastocysts/oocyte (BR) (17%, 21% vs. 9%) (all P<0.01). There was a difference (P<0.01) between 18 and 4 h in FR (69% vs. 48%), PS (13% vs. 4%), and CR (62% vs. 54%), respectively. The bull effect was not significant (P >0.05) for FR (53%, 57%, 62%, 62%), or PS (8%, 9%, 8%, 10%), but CR were higher (P <0.01) for 3 of the bulls (83%, 80%, 76% vs. 58%), and the BR was higher (P<0.05) for two bulls (20%, 20%, vs. 10%, 10%). FR and CR were correlated, r² =0.62. Parthenogenetic, control cleavage (4.1%) stopped at the 8-cell stage. The optimal sperm concentration was 0.33 x 10⁶ /mL. The higher dose caused considerable PS; although the lower concentration decreased PS, it also decreases FR. The longer fertilization time resulted in a higher FR, but more PS.

Key Words: Bovine, IVF, Polyspermy

W233 Fixed-time insemination utilizing an Eazi-BreedTM CIDR[®] in combination with gonadotropin-releasing hormone or estradiol cypionate. K. J. Stutts*¹, D. W. Forrest¹, and C. R. Looney², ¹Texas A&M University, College Station, ²OvaGenix, Navasota, TX.

The objective of this study was to evaluate the efficacy of four estrus synchronization protocols utilizing an intravaginal progesterone-releasing device (CIDR) in combination with estradiol cypionate (ECP) or gonadotropin-releasing hormone (GnRH) on conception rate to a fixed-time insemination in beef heifers. Angus-cross heifers (n=1906) that averaged 13 mo of age and 320 kg BW were randomly assigned to one of four treatments. Treatment (TRT) 1 heifers received a CIDR insert and ECP (1 mg i.m.) on d 0. PGF_{2α} (25 mg) was injected (i.m.) and CIDRs were removed on d 9. A second injection of ECP (0.5 mg) was administered on d 10 and heifers were fixed-time inseminated on d 11. TRT 2 heifers received the same hormonal regimen as TRT 1 except that CIDRs were removed and PGF_{2α} was injected on d 7 followed by the second injection of ECP on d 8 and insemination on d 9. TRT 3 heifers received a CIDR insert and GnRH (50 μg i.m.) on d 0. PGF_{2α} (25 mg) was injected and CIDRs were removed on d 7. A second injection of GnRH (50 μg) was administered and the heifers were inseminated on d 9. TRT 4 heifers received the same hormonal regimen as TRT 3 except that PGF_{2α} was injected on d 6. Beginning 14 d after insemination, heifers were exposed to fertile bulls for 60 d. Conception to the timed insemination was determined by transrectal ultrasonography 30 d after bull removal. Conception rates to fixed-time insemination were different (P<.02) across all treatments. Conception rates to fixed-time insemination for TRT 1, 2, 3, and 4 were 32.4%, 19.6%, 43.2%, and 50.4%, respectively. Overall pregnancy rates for TRT 1 (84.6%), 3 (89.0%), and 4 (87.7%) were higher (P<.0001) than TRT 2 (69.8%). These data indicate that conception rates to timed AI were higher for the CIDR

protocols with GnRH than with ECP, and that injecting PGF_{2α} on d 6 rather than d 7 when using the GnRH/CIDR protocol resulted in a higher conception rate to fixed-time insemination. *Supported by Pfizer Animal Health.*

Key Words: Estrus, Synchronization, Heifers

W234 Deep uterine horn AI improves fertility of lactating dairy cows. J. R. Pursley*, *Michigan State University, East Lansing.*

Currently, fertility levels of lactating cows are approximately 50 % of heifers. This study was designed to determine if fertility of lactating dairy cows could be increased if semen was deposited in the uterine horns compared to the uterine body. Lactating Holstein cows (n=833) from 3 farms were randomly assigned to receive AI in either the uterine body or in the uterine horn by splitting the straw between both horns and depositing the semen near the greater curvature of each horn. Cows were assigned to the two treatments by DIM and parity. Cows received AI following a detected estrus or following Ovsynch (GnRH, 7 d PGF, 48 h GnRH, 16 h AI). Technicians from each farm received training in uterine horn AI prior to the start of the trial. Pregnancy was determined by the farm veterinarian between 35 and 65 d post-AI. Pregnancy rate/AI was greater (P < 0.01) in the uterine horn group compared to uterine body (50 vs. 35 %). There was no effect (P > 0.05) of parity or DIM on pregnancy rate/AI. Pregnancy rate/AI was similar (P > 0.05), and there was no effect (P > 0.05) of treatment, between AI following Ovsynch vs. AI following detected estrus. There was an effect (P < 0.05) of farm on pregnancy rates/AI, but there was no treatment by farm interaction (P = 0.89). All farms had increases in pregnancy rates/AI in cows inseminated in the uterine horns and ranged from 26 to 43 %. In summary, uterine horn AI appears to increase pregnancy rates/AI in lactating dairy cows.

Key Words: Uterine Horn AI, Fertility, Dairy Cows

W235 Addition of ECP or calf removal to a modified MGA + CO-Synch protocol for synchronization of ovulation in beef cows. S. K. Johnson, K. R. Harmoney, and J. S. Stevenson*, *Kansas State University, Manhattan.*

A study was conducted in 735 suckled beef cows to determine if synchronization of ovulation could be improved with estradiol cypionate (ECP) or 48 h calf removal in a modified MGA + CO-Synch protocol. All cows were fed MGA (0.5 mg·hd⁻¹) daily for 14 d (d -32 to -19) and received GnRH (100 µg) on d -7, PGF (25 mg) on d 0, and one fixed time AI at 72 h after PGF. Treatments were applied in a 2 x 2 factorial arrangement of four treatments. Calves either remained with cows (S) or were removed for a 48 h period (CR), beginning 24 h after PGF until after the fixed time AI. Cows either received ECP (E; 1 mg) at 24 h after PGF or GnRH (G; 100 µg) concurrent with fixed time AI. Concentrations of progesterone (P4) were determined in serum samples collected on d -17, -7, 0, and 3. If P4 was ≥ 1 ng·ml⁻¹ on d -17 and/or d -7, cows were classified as cycling. Three locations were studied in year 1 and 2 locations were repeated in year 2. Pregnancy rate to AI (PR) was determined by transrectal ultrasonography on d 33 to 35. The interaction of location nested within year by treatment was significant. The combination of E and S was the least variable of the 4 treatments, with PR ranging from 40 to 58% whereas the other treatments ranged from 29 to 66% from lowest to highest response per location/year. Pregnancy rate was similar for E and G-treated cows (48% and 45%, respectively). Cycling status influenced the response to calf removal. Noncycling CR-treated cows had greater (P<0.05) PR rate than S cows (37% vs. 27%, respectively). Noncycling E-treated cows had greater (P<0.05) PR for CR than S. Cycling E-treated cows had greater (P<0.05) PR for S than CR. Within cycling classification, G-treated cows had a similar response to CR or S. Use of CR in synchronization protocols is most appropriate in herds that anticipate a higher proportion of noncycling cows. Use of ECP to synchronize ovulation did not improve overall PR and required an additional animal handling.

Key Words: Fixed Time AI, Estrogen, Calf Removal

W236 Effect of an addition of a CIDR insert to the Heatsynch protocol on ovulation rate, pregnancy rate and pregnancy loss in lactating dairy cows. K.N. Gavao*, S.O. Juchem, R.L.A. Cerri, A.C. Coscioni, M. Villasenor, and J.E.P. Santos, *University of California Davis, Tulare.*

Objectives were to determine the effects of incorporating a CIDR insert in a pre-synchronized (27 and 41 days in milk (DIM), PGF_{2α} Heatsynch protocol (55 DIM, GnRH; 62 DIM, PGF_{2α}; 63 DIM, estradiol cypionate; 65 DIM, timed AI) on ovulation rate (OR), display of estrus, pregnancy rate (PR), and pregnancy loss (PL) in lactating cows. Holstein cows, 675, from two herds were randomly assigned to treatments. Blood was sampled at 41 and 55 DIM for analysis of progesterone to determine cyclicity. The CIDR was inserted at the time of injection of GnRH, and removed at the the time of injection of PGF_{2α} of Heatsynch. Ovaries were scanned at the time of PGF_{2α} injection and 2 and 7 d later. Pregnancy was diagnosed at 27 and 41 d after AI. Data were analyzed by the LOGISTIC and GLM procedures of SAS (2001). Addition of a CIDR to the Heatsynch protocol eliminated cows displaying estrus prior to the last PGF_{2α} injection (0 vs 2.01%) and decreased proportion of cows bearing a CL at the last PGF_{2α} injection (86.3 vs 93.9%; P<0.001). CIDR did not affect the proportion of cows displaying estrus after the last PGF_{2α} injection (77.2 vs 73.8%; P=0.11) or OR (85.6 vs 86.6%; P=0.30). PR were similar for CIDR and controls on d 27 (35.8 vs 38.8%; P=0.68) and 41 (29.3 vs 32.3%; P=0.33) regardless of cycling status prior to Heatsynch (P>0.15). Pregnancy loss was similar for CIDR and controls (18.3 vs 16.8%; P=0.77). Cyclic cows had higher PR than anovulatory cows at 41 d after AI (33.8 vs 20.4%; P = 0.03) because of lower PL (16.0 vs 30.3; P=0.06). When cows were stratified based on estrus prior to timed AI, at timed AI or no estrus, PR on d 27 (36.9 vs 45.4 vs 17.0%; P<0.001) and 41 (34.2 vs 37.2 vs 12.0%; P<0.001) differed, which might be related to the higher OR (90.0 vs 94.3 vs 63.1%; P<0.001) in cows displaying estrus. PL tended to be lower for cows displaying estrus either prior to or at timed AI than those not in estrus (7.3 vs 18.0 vs 29.6%; P=0.10). Incorporation of a CIDR insert into the Presynch/Heatsynch protocol did not improve PR in lactating dairy cows. Improvements in PR in the Heatsynch protocol are expected when more cows display estrus, thereby increasing synchronization and OR.

Key Words: CIDR Insert, Synchronization, Dairy Cows

W237 Use of milk progesterone following artificial insemination in a resynchronization program for early re-breeding in dairy cows. A. Denson*, T. Dickerson, S. Bowers, S. Schmidt, K. Graves, K. Moulton, and S. Willard, *Mississippi State University, Mississippi State.*

Studies have revealed that the implementation of OvSynch protocols improves synchronization of ovulation and reduces days to first service and days open in dairy cows. Resynchronization of non-pregnant animals in a shortened time-frame post-AI may be beneficial in decreasing days open. The objective of this study was to use milk progesterone (P4) at d 21 following OvSynch and timed-AI to identify pregnant cows and resynchronize non-pregnant cows to accelerate rebreeding. Holstein (n=30) and Jersey (n=10) cows were synchronized using OvSynch and bred AI 16 h post-GnRH. All cows were administered GnRH at d 14 post-AI for resynchronization as part of a subsequent OvSynch protocol. Milk samples were collected on d 21 post-AI to diagnose cows as pregnant or non-pregnant based on qualitative high or low milk P4 (Accufirm). Cows having low P4 were administered PGF_{2α} followed 48 h later with a second administration of GnRH and AI 16 h later. Cows with high P4 were presumed pregnant and not administered PGF_{2α} or GnRH. Blood samples were obtained from all cows on d -9, -2, 0 (AI), 7, 14, 21 through 25 and 28. Blood serum was collected for P4 analysis by RIA. Pregnancy status of cows was confirmed at d 42 post-AI by ultrasonography (US). According to the milk P4 results, 47.5 % of cows were not pregnant to OvSynch/AI based on low milk P4 levels. Serum P4 on d 21 post-AI was low (<1 ng/ml) in 68.4 % of these presumably non-pregnant cows by RIA. Of the 52.5 % of cows with high milk P4 on d 21 post-AI, 85.7 % of the cows exhibited high (>1 ng/ml) serum P4 by RIA. Serum (RIA) and milk P4 on d 21 did not differ (McNemar's test, P>0.10) in pregnant vs. nonpregnant determinations. US at d 42 following the first insemination revealed an overall pregnancy rate of 22.5 %, which represented a 42.9 % pregnancy rate for cows previously identified as pregnant by milk P4 (i.e., US vs. milk P4 disagreed in accuracy of pregnancy rate; McNemar's test, P<0.01). In summary, use

of milk P4 at d 21 post-AI as a selection criteria to identify pregnant cows as part of resynchronization programs may not be accurate enough to justify its use.

Key Words: OvSynch, Milk Progesterone, Synchronization

W238 Use of CIDR with a timed insemination protocol in lactating dairy cows during summer in Mexico. F. Moreira*, R. Flores, and J. Boucher, *Pfizer Animal Health*.

The objective was to evaluate whether addition of EAZI-BREED CIDR Cattle Inserts (CIDR) to the Ovsynch program increases first service pregnancy rate (PR) in lactating dairy cows. The study was conducted in 5 dairies in Central Mexico. Cows were inseminated from June through September, 2001. Within trial site and within parity, cows were assigned to either an Ovsynch (n=255) or an Ovsynch-CIDR group (n=255) for their first service. Ovsynch was initiated at 50±3 d postpartum with an injection of 100 µg of GnRH (2 mL, i.m.; CYSTORELIN), an injection of 25 mg of PGF_{2α} (5 mL, i.m.; LUTALYSE Sterile Solution) 7 d later, a second 100 µg injection of GnRH 48 h later, and timed insemination 8 to 20 hours after the second GnRH injection. Ovsynch-CIDR cows received the same treatments but also received a CIDR Insert (1.38 g of progesterone) which was administered with the first GnRH injection and removed 7 d later at the PGF_{2α} injection. Cows were palpated for pregnancy 40 to 45 d after timed insemination. An interaction between treatments and parity was detected (P=0.023). The interaction indicated that PR was increased for Ovsynch-CIDR compared to Ovsynch in primiparous cows (38.2% and 20%, respectively; P=0.024) but no differences were detected in multiparous cows (22.3% and 27.5%, respectively; P=0.375). A subset of cows (n=466) was classified as anestrous or cyclic based on progesterone concentrations of two blood samples collected 7 d prior to and at the first GnRH injection. For anestrous cows, PR was 18.8% for Ovsynch (6/32) and 18.4% for Ovsynch-CIDR (7/38). For cyclic cows, PR was 23.5% for Ovsynch (47/200) and 29.1% for Ovsynch-CIDR (57/196). Such effects were further subdivided according to parity but none were significant. Addition of CIDR increased first service pregnancy rates of primiparous but not multiparous lactating dairy cows submitted to an Ovsynch program. Because cows were inseminated during summer,

heat stress might have affected embryonic survival but the study was not designed to specifically address such an effect.

Key Words: CIDR, Ovsynch

W239 Efficacy of an injection of Dinoprost Tromethamine when given subcutaneously in two different sites on luteal regression in lactating Holstein cows. R. C. Chebel¹, J. P. Reynolds¹, R. L. A. Cerri¹, J. Versteeg², H. M. Rutigliano¹, and J. E. P. Santos¹, ¹University of California Davis, Tulare, ²Pfizer Animal Health.

The objective of this study was to compare the efficacy of administration of 25 mg of dinoprost tromethamine sterile solution (Lutalyse, Pfizer Animal Health) through different routes and in different sites on luteal regression. Lactating Holstein cows, 109, were synchronized with one injection of PGF_{2α} 14 d prior to enrollment (study d 0). On study d 0, cows were examined by ultrasonography to determine presence of a CL in one of the ovaries. Cows with CL were blocked by parity and d in milk and, within each block, randomly assigned to receive PGF_{2α} as an i.m. injection in the semimembranous/semitendinous muscle (CON); subcutaneous injection in the cervical area (SC); and subcutaneous injection in the ischiorectal fossa (SCI). Blood was sampled at 0, 12, 24, and 48 h after treatments for measurement of plasma progesterone concentrations using a validated EIA. Luteal regression was considered when progesterone decreased to less than 1.0 ng/ml. Relative changes in progesterone (0h=100%) were evaluated after PGF_{2α} injection. Continuous and binomial data were analyzed by the MIXED AND LOGISTIC procedures of SAS (2001), respectively. CL regression for CON, SC, and SCI at 24 (65.7 vs 64.1 vs 68.6%; P=0.92) and 48 h (94.3 vs 86.8 vs 88.6; P=0.55) after treatment did not differ. Relative changes in progesterone (0 = 100%) at 12, 24, and 48h after treatment were 50.4, 34.5, and 27.7% for CON, 53.0, 33.1, and 28.4% for SC, and 52.4, 32.5, and 30.6% for SCI, and no effects of treatment (P=0.98) or treatment by time interaction (P=0.87) were observed. Injection of 25 mg of dinoprost tromethamine subcutaneously in the cervical area or ischiorectal fossa resulted similar changes in progesterone and luteal regression when compared with an i.m. injection in the semimembranous/semitendinous muscle.

Key Words: Prostaglandin, Luteolysis, Dairy Cows

Production, Management and the Environment: Reproduction and Health Management

W240 A herd health management program resulted in decreased days open in first lactating cows in northern Thailand. K. Kreausukon¹, V. Punyapornwitthaya¹, P. Kattapan², and W. Suriyathaporn³, ¹Clinic of Ruminant, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai Province, Thailand, ²Lumphoon Office of Department of Livestock Development, Thailand.

The herd health management program (HH) is used to improve production performance in dairy farms, especially in Europe and North America. In northern Thailand, the HH program was introduced a few years ago by the faculty of Veterinary Medicine, Chiang Mai University. Therefore, the goal of this study was to evaluate the HH program on reproductive performance in the primiparous crossbred holstein cows. Data from 27 farms in Lamphun province during 1999 to 2003 were used to compare reproductive efficiencies before and after participating in the HH program that started in October 2001. Data on calving date, insemination date, and pregnancy check date were recorded. Calving and breeding season were divided into 3 seasons based on Thai Meteorological Department data, summer (mid Feb.–mid May), rainy (mid May–mid Oct.), and winter (mid Oct.–mid Feb.). The HH program factor was divided into two groups: before and after participating in the program. Factors associated with pregnant cows within 120 days postpartum were evaluated by Cox model. Results from 177 cows showed that median of days open of cows before and after the program were 155 and 129 days, respectively. Results from the Cox's model showed that conception rate after participating in the HH program was increased significantly (HR = 1.96). In addition, conception rate of cows inseminated during the rainy season was lower than in summer (P = 0.07, HR = 1.82) and winter (P < 0.05, HR = 2.28). In conclusion, the HH manage-

ment program improved reproductive performance of primiparous cows in northern Thailand.

Key Words: First Lactating Cows, Days Open, Cox Model

W241 Pregnancy rates and serum cortisol concentrations of relocated recipient cows in an embryo transfer program. J. L. Lopez*, E. Gonzalez, and D. L. Fernandez, *California State Polytechnic University, Pomona*.

Embryo transfer pregnancy rates are lower than pregnancy rates reported for AI or natural service, resulting in a significant economic loss to producers. Recipient cows in embryo transfer programs are routinely relocated. Relocation includes transportation, social regrouping of the animals, climate changes and dietary changes, among others, the stresses of which constitute relocation stress. Because stress affects reproduction, we hypothesized that relocation stress may play an integral role in the success rates of embryo transfer pregnancies. Recipient cows from Montana and Oregon (n=17) were relocated to California State Polytechnic University, Pomona (CPP) and cows from CPP (n=57) were used as non-relocated controls. All cows were treated identically in regards to diet, management and climate after arriving at CPP. Cows were synchronized for estrus and were implanted with Day 7 embryos 7 d after behavioral estrus. Blood samples were collected, centrifuged and the serum stored at -20°C until assayed for cortisol by RIA. The cows were palpated *per rectum* for evidence of pregnancy 60 days after implantation (Day 67) and another blood sample was collected. There was no difference ($\chi^2 = 2.42$, p > 0.10) in pregnancy rates between the control (61%) and the relocated (41%) cattle. Cortisol levels were not different (1.66 ± 0.40 vs. 1.67 ± 0.20 ngml⁻¹, respectively, p > 0.10) between

pregnant and non-pregnant cattle. Cortisol levels were higher 60 days after embryo transfer than day of embryo transfer (2.05 ± 0.24 vs. 1.28 ± 0.33 ngml⁻¹, respectively, $p = 0.059$). We reject our hypothesis that relocation stress reduces pregnancy rates in embryo transfer recipient cows, and hypothesize that relocation stress affects the hypothalamic-pituitary-gonadal axis to reduce fertility, not the cows ability to carry an embryo transfer pregnancy to term.

Key Words: Stress, Cortisol, Embryo Transfer

W242 Evaluation of temperature and temperature-humidity index and their effects on reproduction in beef cattle. J. L. Amundson*, T. L. Mader, R. J. Rasby, and Q. S. Hu, *University of Nebraska-Lincoln.*

Elevated ambient temperatures and humidity during the breeding season can decrease female fertility, reduce the duration of estrus, and results in a lengthened postpartum interval in cattle. The objective of this study was to quantify the effect of temperature-humidity index (THI) on pregnancy rate (PR) of beef cattle. Ten years of calving records were examined from a 150 head herd of commercial, *Bos taurus*, crossbred cows. Cows were managed at the University of Nebraska Dalbey-Hallack Research Farm, located in southeast Nebraska. All cows were bred by natural service, beginning in late May, with a breeding season of 65d. Breeding date was determined by subtracting 283d from the calving date. Relationships were determined between the proportion of cows bred in the first 30d, 60d and the entire breeding season to corresponding average temperature and THI. Weather data were compiled from a Great Plains Climate Center Weather Archives weather station located approximately 20 km from the research site. Average daily temperature and relative humidity were used to calculate daily THI. Average temperature ($R^2=0.38$; $P=0.06$) and THI ($R^2=0.44$; $P=0.04$) for the first 30d of the breeding season decreased PR 1.95 and 1.38% per unit increase in temperature and THI, respectively. Average THI greater than 65 for the first 30d decreased ($P=0.08$) pregnancy rate 1.60%/THI unit ($R^2=0.58$), but had no effect later in the breeding season. In years where the 60d average THI was greater than 70, PR in 60d decreased 3.15%/THI unit ($R^2=0.84$, $P=0.08$) but had no effect on PR for the remainder of the season. Among all years, season THI had no effect ($P>0.1$) on pregnancy rate ($R^2=0.01$). However, the correlation was greater for years where the average THI exceeded 70 ($R^2=0.43$; $P>0.1$). Temperature and THI can reduce 30 and 60d pregnancy rates in beef cows that are pasture bred during years of above average temperature and THI in Southeast Nebraska. However, females acclimatize to temperature and resulting THI because PR did not differ among years.

Key Words: Beef Cattle, Heat Stress, Temperature-Humidity Index

W243 Synchronization of beef cows using GnRH, prostaglandin F_{2α}, and estradiol. W.A. Greene and M.L. Berger*, *The Ohio State University, Wooster.*

The main objectives of this study were to investigate the effect of the addition of estrogen to a common synchronization program on estrus detection rates (EDR) and pregnancy rates (PR). Eighty-four beef cows were allotted to two similar groups (CTRL and ECP) based upon breed, age, postpartum interval, and postpartum cyclicity (as determined by ultrasonography). Each anestrus cow ($n=25$) received an intravaginal releasing device (CIDR), containing 1.38 g progesterone, from d 0 to d 7. All cows received 50 μg GnRH i.m. on d 0 and 25 mg PGF_{2α} i.m. on d 7. The estrogen (ECP) group cows received 0.5 mg estradiol cypionate i.m. 24 h after PGF_{2α}. 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, CTRL cows were timed AI (TAI) 66 h after PGF_{2α} and received 50 μg GnRH i.m. 0-4 h after AI while ECP cows were TAI 48 h after ECP injection. Following the synchronization period, repeat breedings were done until d 49. Cows were pregnancy diagnosed by ultrasonography on d 80. CTRL and ECP groups had similar ($P>.05$) EDR to synchronization (22.5 and 24.4%), PR to synchronization (30.0 and 36.6%), and overall PR (92.5 and 80.5%). Statistically, the only difference noted was that PR to synchronization was higher

($P=.03$) for anestrus than cycling cows (52.0 vs. 25.0%), perhaps due to the insertion of a CIDR in all anestrus cows.

Key Words: Beef, Synchronization, Pregnancy Rates

W244 Monitoring of estrus characteristics in pubertal and pregnant heifers using radiotelemetry. M. Paczkowski*, T. Craig, D. Magee, J. Thompson, and D. Forrest, *Texas A&M University, College Station.*

Prepubertal (age= 9.5 mo old) Angus-sired heifers ($n=21$) were fitted with HeatWatch® (HW) transponders and continuously monitored for mounting activity. Estrus was defined by a minimum of 3 mounts within a 4-hr interval. Heifers were artificially inseminated (AI) at the second observed estrus. Pregnancy was confirmed 30 d after AI via ultrasound and all pregnant heifers were monitored with HW for at least 35 d up to a maximum of 220 d gestation. The GLM and Mixed Procedures of SAS were used to compare number of mounts, total mount duration, and estrus duration between the pubertal and second estrus. Mean duration of estrus was longer ($P<0.01$) for the second (17.54 ± 3.42 hr) than for the pubertal (12.42 ± 3.42 hr) estrus. Total mount duration and number of mounts did not differ ($P>0.60$) between the pubertal and second estrus. Logistic regression was used to determine if the characteristics of the second estrus were associated with pregnancy (yes/no). Number of mounts at second estrus were greater ($P<0.05$) for pregnant than for non-pregnant heifers after AI. Mean duration of estrus and total mount duration at second estrus were not significantly associated with pregnancy outcome. Estrus events as defined by HW ($n=73$) that occurred during gestation were recorded in 9 heifers. The interestrus intervals during gestation were distributed as follows: <10 d= 48%, 10-16 d= 27%, 17-24 d= 10%, and >24 d= 15%. The Mixed Procedures of SAS were used to determine whether characteristics of the second estrus were predictive of characteristics of estrus during gestation (number of mounts, total mount duration, and interestrus interval). Number of mounts ($P<0.04$) and total duration of mounts ($P<0.02$) at second estrus were predictive of number of mounts during gestation. We conclude that estrus duration is longer for the second estrus compared to the pubertal estrus and the number of mounts received during the second estrus was greater in heifers that were pregnant after AI compared to non-pregnant heifers. Supported by Merial LLC.

Key Words: HeatWatch, Estrus, Pregnancy

W245 The effect of body weight change on conception. C. D. Dechow*, J. E. Vallimont, and M. L. O'Connor, *The Pennsylvania State University, University Park.*

The objective of this study was to estimate the effect of body weight change two weeks prior to insemination (WC14) on the success of insemination. The Afimilk computerized milking and management system records daily body weights for each Penn State dairy cow upon exiting the milking parlor. Body weights and insemination results from the first 200 DIM were retained. Lactation records with fewer than four usable daily body weights over any two week lactation period were eliminated. The final dataset included 77 lactation records from 65 cows with 154 inseminations from 2002 through 2003. Daily body weight variation due to gut fill and measurement error was accounted for by nesting fixed 5th order polynomials of DIM in each lactation record using the PROC MIXED procedure of SAS. A random effect of date was included in the model and regression results were used to reconstruct body weight curves for a cows lactation. The reconstructed body weight curves were then used to derive WC14. Positive values for WC14 indicate cows were losing weight prior to an insemination; a negative value for WC14 indicates cows were gaining weight prior to an insemination. Quartiles of WC14 were constructed (Q1=<-7.7 kg, Q2= -7.7 kg to -2.9 kg, Q3= -2.8 kg to 3.8 kg and Q4=>3.8 kg). Conception outcome (1 = pregnant, 0=open) was treated as a binary response variable in the PROC NLMIXED procedure of SAS. Significant effects included fixed year-season of insemination and WC14 quartiles. Conception outcome was significantly different ($p<.05$) between Q1 and Q4 (odds ratio = 4.2). Conception outcome was also significantly different if WC14 quartiles were expressed as a percentage of body weight lost prior to insemination (Q1:Q4 odds ratio = 3.7). Cows losing more than 3.8 kg of body weight were significantly less likely to conceive than those cows gaining

more than 7.7 kg. Automated daily body weight measurements can be used as a reproductive management tool to optimize the likelihood of conception.

Key Words: Body Weight, Conception, Fertility

W246 Productive and reproductive performance of bathed Holstein cows during the summer. M. Tarazon*, J. Valenzuela, S. Araiza, and F. Denogean, *Universidad de Sonora, Hemosillo, Mexico.*

The objective of the current study was to evaluate the effects of daily baths during the summer months on productive and reproductive performance of multiparous Holstein cows. Eighteen cows were assigned to one of the two groups in a completely randomized design. The treatment group consisted of nine cows, which received a daily bath 30 days before and 30 days after the expected calving date; while the nine cows from the control group did not receive the bath. Cows on treatment were bathed at 15:00 hours using a hose to completely wet the body of the animal. Twenty-five liters of water, at 26 to 29° C were used to wet the animal. Temperature and relative humidity were taken and recorded once every other day at 16:00 hours. Rectal temperatures were measured on all cows during the experimental period. Milk productions from all cows were measured three times a week and daily milk productions were estimated. Days open and services per conception were obtained from the dairy farm records. Also, data from the previous lactating period were used as a covariance. Data were analyzed by the statistical model from Costat) Cohort software, 1986-95).

One of the cows from the group that received the baths, died due to mastitis. The highest temperature and relative humidity were recorded during July (44° C y 68%, respectively) and the lowest ones were during June (35° C y 40%, respectively). Milk yields were not altered by the treatment. Open days for treated cows were numerically lower than the non treated cows, but the difference was not significant. In the same way, services per conception were numerically higher in non treated than in treated cows, but the difference was not significant. Rectal temperatures were significantly ($P < 0.05$) reduced in treated cows before and after calving.

Key Words: Milk Production, Bathed Cows, Temperatures

W247 Financial losses and management practices associated with BTSCC. A. C. O. Rodrigues*, D. Z. Caraviello, and P. L. Ruegg, *University of Wisconsin-Madison.*

The objective of this study was to determine the relationships among bulk tank somatic cell count (BTSCC) and financial and management characteristics of Wisconsin dairy farms enrolled in a state-wide team-based milk quality program. Management and financial data was obtained from a sample of enrolled dairy farms ($n = 149$). The logarithm of BTSCC (LogBTSCC) was regressed on meeting year, season, number of lactating cows, average milk production per cow per day, and financial and management attributes. Linear effects, nonlinear effects and interactions were estimated for financial and management characteristics. The median LogBTSCC was 5.52 (range of 5.08 - 6.07) and the number of lactating cows was 129 (22 - 1838) having a mean RHA of 10034.5 kg. The logarithm of standard plate count had a significant positive correlation with LogBTSCC ($\rho = 0.001$). As LogBTSCC increased the monthly clinical mastitis rate (0.07) and mastitis cull rate (0.02) increased in a significant positive linear association. The duration of milk discard for clinical cases of mastitis was 6.1 days and accounted for 58.8% of total costs. Both the average linear score of first lactation cows (2.97) and second or greater lactation cows (3.7) were higher on farms with higher LogBTSCC resulting in a significant greater monthly production loss per cow due to subclinical mastitis ($\rho = 0.004$). At enrollment in the program, herds received \$0.001 per kg of milk in quality premiums in contrast to available premiums of \$0.011 per kg of milk for achieving their goal SCC values (mean of 188,320 cells/ml). The monthly premium opportunity was positively associated with LogBTSCC. Forestripping and predipping were adopted by 83.7% and 89.1% of farms, respectively. Farms that did not always use gloves during milking cow preparation had higher LogBTSCC as compared to

farms that did use. The use of CMT paddle was associated with lower LogBTSCC ($\rho = .012$).

Key Words: Milk Quality, Management, Finance

W248 Consistency Index as a Dynamic Field Measure of BTSCC Variation. J. Lukas*¹, M. L. Kinsel², and J. K. Reneau¹, ¹University of Minnesota, St. Paul, ²Agricultural Information Management, Inc., Ellensburg, WA.

The objective of this study was to investigate differences in variation in BTSCC depending on the mean BTSCC and develop a field friendly measure of process performance by deriving a consistency index (CI) chart that calculates the maximum allowable sigma to meet each of the following SCC standards: 750000, 600000, 500000, 400000. Bulk tank SCC data was collected daily or every other day for 6 months (January until June 2003) from 1764 Upper Midwest dairy farms. The mean of daily values and variation (sigma) in BTSCC was calculated for each individual herd. The herds were divided into seven categories depending on the mean BTSCC for the 6-month period (mean BTSCC in thousands <150, 150-200, 200-300, 300-400, 400-500, 500-600, 600-750). Average sigma was calculated for each of the seven categories and the relationship between the mean and sigma was investigated. A consistency index (CI) was developed that calculates the maximum allowable sigma to meet the SCC standard at a given mean BTSCC following the formula: $CI = (\text{standard} - \text{mean})/3$ where mean is the average BTSCC and the standard represents one of four different BTSCC standards. CI400 was developed for the 400000 SCC standard imposed in the EU. CI500 relates to the 500000 SCC standard adapted in Canada. CI600 uses the 600000 SCC limit implemented in California while CI750 is based on the 750000 SCC limit obligatory in other states. Analysis of the relationship between the mean and variation of BTSCC indicated that in herds which on average have a low BTSCC, the variation in BTSCC is low. The variation increases as the mean BTSCC increases. Using the consistency index (CI) chart, dairy managers and milk plant field staff can indicate what level of variation (consistency) will have to be achieved to meet a milk quality standard with statistical certainty. The same kind of chart could also be used to assess the prospect of meeting quality premium goals and to encourage improvement in process consistency as a means of further BTSCC improvement.

Key Words: BTSCC, Consistency Index, Statistical Process Control

W249 Factors affecting raw milk quality at milk collecting center-level in Northern Thailand. S. Boonyayatra¹, S. Rojanasthien¹, K. Kreausukon*¹, P. Tharavichitkul², and K. Ajariyakhajorn³, ¹Faculty of Veterinary Medicine, Chiangmai, Thailand, ²Faculty of Medicine, Chianmai, Thailand, ³Faculty of Veterinary Science, Bangkok, Thailand.

To study the herd-level factors affecting the microbiological quality of raw milk at the milk collecting center (MCC), Standard plate count (SPC) was conducted to evaluate the bacterial counts in raw milk samples every week for 2 consecutive months from 4 MCC in Northern Thailand. These selected MCC were divided by the median of average SPC from all MCC in this area into 2 groups; group1: MCC which had low bacterial count ($SPC < 1.6 \times 10^6$ cfu/ml) and group2: MCC which had high bacterial count ($SPC > 1.6 \times 10^6$ cfu/ml). Then, the questionnaires were administered by interviewing about the farm management and observing for the milking technique in 104 dairy farms: 50 and 54 farms for group1 and 2, respectively. The logistic regression modeling technique was used to evaluate the significance of association of each factor while simultaneously controlling for the presence of other factors. The results showed that long duration of dairy farming (OR = 1.137, 95%CI 1.022 - 1.265), high number of milking cows (OR = 1.220, 95%CI 1.033 - 1.440), udder not dry before attachment (OR = 5.817, 95%CI 1.867-18.129) and poor cleanliness of teat cup liner (OR = 6.444, 95%CI 1.835-22.627) were the risk factors to have high level of bacterial contamination in raw milk at the MCC-level. In conclusion, the farmer should pay more attention on milking hygiene and cleanliness of milking equipment to improve the microbiological quality of raw milk at the milk collecting center.

Key Words: Raw Milk Quality, Milk Collecting Center, Northern Thailand

W250 Effect of season on high bulk milk somatic cell count in northern Thailand. S. Rojstian*, V. Punyaporn-wittaya, W. Tiwanuntakorn, S. Boonyayatra, J. Younggad, C. Apairoj, and W. Suriyasathaporn, *Department of Clinic of Ruminant, Faculty of Veterinary Medicine, Chiangmai University, Chiangmai, Thailand.*

The objective of this study was to evaluate the effect of season on bulk milk somatic cell count (BMSCC) in Northern Thailand. Data of BMSCC from 123 dairy farms within 4 milk-collecting centers in Chiang Mai and Lumpun provinces, Thailand, were collected once a month between October 2000 to August 2001. By the definition from Thai Meteorological Department, seasons in Thailand are comprised of winter (Nov.-Feb.), summer (Mar.-May), and rainy season (Jun.-Oct.). High BMSCC was defined when farms had BMSCC higher than 500,000 cells/ml. The percentage of farms with high BMSCC from each milk-collection center and each month was a dependent variable. Seasons and milk-collecting center factors were fixed effects. Data was analyzed using mixed model analysis (Proc Mixed, SAS v.8). Results showed that both season and milk-collecting center were related to the proportion of high BMSCC farms ($P < 0.05$). The percentages of high BMSCC of all centers were ranged between 5.4 and 37.9. The percentage of high BMSCC in rainy season (30.7 %) was significantly higher than summer (20.7 %) and winter (22.4 %). We concluded that a problem of sub-clinical mastitis for dairy farms in northern Thailand is highest during the rainy season.

Key Words: Bulk Milk Somatic Cell Count, Season, Cows

W251 Growth and parasite burdens of St. Croix White and Dorper X St. Croix White lambs grazing native pasture during the wet season in the US Virgin Islands. R. E. Dodson*, A. J. Weis, and R. W. Godfrey, *University of the Virgin Islands, Agricultural Experiment Station, Kingshill, VI.*

St. Croix White (STX; $n = 16$) and Dorper X STX (DRP; $n = 14$) ewe and wether lambs were used to evaluate the growth of lambs grazing during the wet season under tropical conditions. Two wk after weaning, at 63 d of age, lambs were placed in guinea grass (*Panicum maximum*) pastures (0.5 ha) in a rotational grazing system for 147 d. Daily rainfall amounts were recorded during the grazing period. Lambs were moved between pastures every 20 ± 3 d. Forage quantity was determined at the start and end of grazing within each pasture. Each week for the first month and every two weeks thereafter lamb weight, fecal egg count (FEC) and packed cell volume (PCV) were determined for each lamb. The pastures received 978.7 mm of rain with 64.5% of the rain falling by d 45 of the grazing period. Forage quantity was 1264.2 ± 413.9 and 627.5 ± 126.2 Mg/ha at the time of entry into and exit from pastures, respectively. Forage contained 13.3 ± 0.7 % crude protein and 60.8 ± 0.6 % TDN. Average daily gain was higher ($P < 0.05$) for DRP than for STX lambs (76.8 ± 3.8 vs 64.8 ± 4.3 g/d, respectively) and wethers

had higher ADG ($P < 0.009$) than ewes (79.2 ± 4.1 vs 62.5 ± 4.1 g/d, respectively). Wether lambs were heavier than ewe lambs within breed ($P < 0.001$) during the grazing period but there was no difference ($P > 0.10$) between breeds. There was no breed x gender interaction for ADG or BW. There was no difference ($P > 0.10$) between DRP and STX lambs in FEC or PCV during the grazing period. Packed cell volume was negatively correlated ($P < 0.0001$) with FEC in DRP and STX lambs ($r = -0.71$ and -0.67 , respectively). Weight was positively correlated ($P < 0.009$) with PCV in DRP and STX lambs ($r = 0.15$ and 0.16 , respectively). In 3 lambs that died FEC was 2350 egg/g and PCV was 10% the week immediately prior to their death. These results indicate that DRP lambs grow faster and have similar parasite burdens when compared to STX lambs grazing native pasture during the wet season under tropical conditions.

Key Words: Sheep, Parasites, Grazing

W252 Phylogenetic relationship and distribution of bacteria in the mucosa of chicken guts: from the crops to ceca. J. Gong¹, W. Si^{*1}, R. Huang², F. Deng¹, Y. Yin¹, H. Yu¹, and Y. Han³, ¹Food Research Program, Agriculture and Agri-Food Canada, Guelph, Ontario, ²Institute of Subtropical Agriculture, Chinese Academy of Sciences, Changsha China, ³Maple Leaf Foods Agresearch, Guelph, Ontario.

Bacterial populations in the mucosa of adult chicken guts at different regions, including the crop, gizzard, duodenum, jejunum, ileum, and cecum, were studied by molecular analysis of 16S rRNA genes. Bacteria in the mucosa of tested gut regions were mainly Gram-positive. Ceca had the most diverse bacterial population in the guts. Eleven out of 100 cloned 16S rDNA sequences from the cecum had less than 95% homology to database sequences. There were 56 phylogenetic types of bacteria (from 100 16S rDNA clones) detected in the cecum, as compared to 8 phylogenetic types (from 51 clones) in the crop, 3 phylogenetic types (from 51 clones) in the gizzard, 15 phylogenetic types (from 52 clones) in the duodenum, 11 phylogenetic types (from 50 clones) in the jejunum, and 7 phylogenetic types (from 50 clones) in the ileum. *Bifidobacterium* and *E. coli* comprised the largest groups among the clones from the cecum, representing 12 and 11%, respectively. *Lactobacilli* were predominant (181 out of 254 clones) in the upper gastrointestinal tract (from crops to ilea) with the highest diversity being found in the crop. *L. aviarius* was the predominant species of *Lactobacilli* detected in the gizzard and duodenum. It also comprised the largest group of bacteria in the jejunum and ileum. This report is the first comprehensive study of mucosa-associated microbiota from different gut regions in broiler chickens.

Key Words: 16S rRNA, Bacteria, Chicken Gut

Breeding and Genetics II

W253 A computerized approach to minimize inbreeding of breeding plans. John R. Garbe* and Yang Da, *Department of Animal Science, University of Minnesota, St Paul.*

Inbreeding is an important issue in animal breeding. Since inbreeding is often associated with detrimental effects, minimizing inbreeding is often desired. Theoretical prediction of inbreeding levels for breeding plans is difficult in real animal populations due to the complex pedigree structures formed over many generations. As computing power rapidly improves, predicting inbreeding levels based on exhaustive calculation of inbreeding coefficients resulting from all potential matings becomes feasible. We developed a computer program named MiniInbred to identify a breeding scheme that minimizes inbreeding. This program predicts inbreeding level in the next generation by identifying matings that yield the lowest inbreeding level in the offspring. The inbreeding coefficient resulting from all potential matings of the current breeding animals (generation 1) are calculated, and the potential matings among the current breeding animals that yield the lowest inbreeding level are identified. The program also has the option to predict the lowest inbreeding available in the third generation. In this case, the hypothetical offspring (generation 2) of the current breeding animals are treated as parents, and the inbreeding coefficient resulting from all potential matings between the hypothetical parents are calculated, and the potential matings among the hypothetical parents that minimize inbreeding are

identified. This computerized approach is illustrated and evaluated using two large animal pedigrees.

Key Words: Inbreeding, Breeding, Animal

W254 Full pedigree analysis of QTL affecting growth, carcass, and meat quality in pigs. N. Vukasinovic*¹, F.-X. Du¹, L. A. Messer¹, J. C. Byatt¹, M. M. Lohuis¹, A. C. Clutter¹, J. Bennewitz², N. Reinsch², G. Otto², K. Sanders², N. Borchers², and E. Kalm², ¹Animal AG, ²Institute of Animal Breeding and Husbandry, Kiel, Germany.

Quantitative trait loci (QTL) detection methods in swine are often based on full- or half-sib families and ignore additional relationships among animals. In this study, a full-pedigree analysis based on a variance component (VC) approach was applied to a three-generational pedigree from a line-cross experiment involving Pietrain and Large White x Landrace hybrid. The pedigree included 17 F0, 118 F1, and 1014 F2 animals originating from repeated matings of four F1 sires to 33 full-sib F1 dams. All animals were genotyped for 27 microsatellite markers on SSC2, SSC6, and SSC7. Phenotypes on 31 growth, carcass, and meat quality traits were available on F2 animals. The analyses were performed using an animal model with random polygenic and QTL effects. The (co)variance

matrix of the polygenic effect was an additive genetic relationship matrix. The (co)variance matrix of the QTL effect contained probabilities that alleles shared by two individuals were identical-by-descent (IBD). The IBD probabilities were calculated for each pair of gametes independently, using a deterministic method that combines a recursive algorithm for general pedigree structure with the method to estimate IBD between sibs, and then combined to obtain IBD probabilities at the individual's level. The VC analysis was performed and LOD scores were obtained at every 1cM. Significant evidence of QTL (LOD>2) affecting daily gains, most fatness traits, meat reflectance and conductivity was found on SSC2. For some traits, more than one significant peak was found, indicating possible presence of two or more linked QTL. There was suggestive evidence (LOD>1.5) of several QTL affecting fatness traits on SSC6. On SSC7, we found a very significant (LOD=14.5) QTL for carcass length. Full pedigree analysis provides stronger evidence of existing QTL and more precise estimates of their positions than traditional methods.

Key Words: Swine, QTL Mapping, General Pedigree

W255 Efficiency of selection on multiple QTL in a crossbred population. N. Piyasatian*, R. Fernando, and J. Dekkers, *Iowa State University, Ames.*

The efficiency of marker-assisted selection on multiple known QTL for a trait with heritability of 0.1 in a line-crossing program was evaluated on the basis of frequencies of favorable QTL alleles and genetic gain over ten generations. Three biallelic unlinked additive QTL were simulated with known QTL positions. Polygenic effects were simulated based on the sum of 100 additive and unlinked loci. Different analyses and criteria for selection were evaluated by considering the effects of factors included in the models and three alternative levels of effects at the QTL (each QTL explaining 10.8, 3.57, and 0.9% of the genetic variance). In each generation 5% males and 25% females were selected out of 500 progeny. Two alternative analyses were considered:

Model A: $\mathbf{Y} = \mathbf{X}_n \beta_n + \mathbf{X}_g \beta_g + \mathbf{Zu} + \mathbf{e}$, and Model B: $\mathbf{Y} = \mathbf{X}_n \beta_n + \mathbf{Zu} + \mathbf{e}$

where \mathbf{Y} is the observed phenotypes; β_n and β_g are non-genetic and genetic fixed effects (= number of favorable QTL alleles); \mathbf{X}_n and \mathbf{X}_g are incidence matrices; \mathbf{u} are additive polygenic effects; and \mathbf{e} are the environmental effects. Selection was based on the sum of BLUE of β_g and BLUP of \mathbf{u} . A total of 50 replicates were run.

For the large QTL, QTL frequencies approached fixation (>0.9) in generations 6 and 10 for Models A and B. For the smaller QTL, it required more generations to approach fixation, in particular for Model B. In generation 2 (F2), genetic gain from Model A was 70% greater than gain from Model B for the large QTL, 20% greater for the medium QTL, and 10% poorer for the small QTL. The latter likely results from the large standard errors of QTL effect estimates for the small QTL. For the large and medium size QTL, extra gains of Models A over B declined over generations. Results show that QTL detected in breed crosses can be used to increase genetic gain in populations that are developed from those crosses. Additional analyses will evaluate the impact of having markers at various distances from the QTL.

Key Words: QTL, Marker-Assisted Selection, BLUP

W256 Comparison of normalization and models for the analysis of gene expression data. S. L. Rodriguez-Zas*¹, M. R. Band², R. E. Everts¹, B. R. Southey¹, Z. L. Liu¹, and H. A. Lewin^{1,2}, ¹University of Illinois at Urbana-Champaign, ²W. M. Keck Center for Comparative and Functional Genomics, University of Illinois at Urbana-Champaign.

The influence of different normalization and parametric models on the analysis of gene expression from three cattle tissues (rumen, large intestine and small intestine) was evaluated. Fluorescence intensities were recorded in cDNA microarrays that included over 6000 double-spotted cattle genes. A total of six microarrays were used in a reference design with reverse labeling. Prior to normalization, individual spots were filtered if the fluorescence intensity was weak or extreme relative to the sample mean for each gene. The fluorescence intensity normalization methods used were log2 transformation, loess transformation, and linlog at 30% intensity transformation and the combination of loess and linlog transformations. Normalized data were then analyzed using three

response variable-model combinations, tissue intensity divided by reference intensity (RATIO), reference intensity treated as a response variable together with the tissue intensities (ABSOLUTE) and reference intensity included in the model as a covariate dependent variable (COVARIATE). A linear mixed effects model including the effects of dye and tissue was fitted and model adequacy was determined by the mean square error criterion. Across all normalization methods, the ABSOLUTE model provided the worst fit and the RATIO and COVARIATE models provided similar fit. However the ABSOLUTE model provided the most significant genes and the COVARIATE model the fewest significant genes. The average difference across normalization methods in the number of genes differentially ($P < 1 \times 10^{-8}$) expressed among tissues was 201 between the ABSOLUTE and COVARIATE models. The log2 transformation provided the worst fit and the combined transformation provided the best fit across all models. The combination transformation provided the most significant results and the linlog provided the fewest. The average difference across models in the number of genes of differentially ($P < 1 \times 10^{-8}$) expressed was 76 between the combined and linlog normalization methods. The variation in results indicates that every cDNA microarray experiment must be studied using different normalizations and models.

Key Words: Gene Expression, Normalization, Mixed Effects Model

W257 Graphical visualization of two large complex populations using Pedigree 2.0. J. R. Garbe* and Y. Da, *Department of Animal Science, University of Minnesota, St. Paul.*

This poster presents pedigree drawings for two large and complex pedigrees to evaluate the capabilities of Pedigree 2.0 developed by the authors. Pedigree 1 is a sub population of the entire US registered Jersey population with 1.3 million daughters from 579 sires in 8 generations. The pedigree drawing used the summarization option that displays the sires and their parents, as well as the counts of daughters of each sire according to the performance of pregnancy rate. The program took 43 minutes to draw the full pedigree on a 2 GHz PC computer. To print out the entire drawing with readable entries would require a piece of paper 17 feet wide and 4 feet tall. Pedigree 2 is the European royal genealogy data (unofficial data available from the internet) with 48,605 individuals spread out over 106 generations, with entries as early as 827 BC and as recent as 1997. The program took 43 minutes to draw the full pedigree on a 2 GHz PC computer. Color lines connecting parents and offspring were used to enhance the visibility of parent-offspring relationship. Using zoom in would allow a clear view of any part of the pedigree. However, to print out the main body of the entire drawing with readable entries would require a piece of paper 80 feet wide and 200 feet tall. Using Pedigree's option of extracting partial pedigrees, we produced the pedigree drawing of Victoria Hanover, Queen of Britain. This partial pedigree contains 5,124 individuals, 3,975 ancestors and 1,148 descendants, and is viewable without the need of an excessively large print. The results show that pedigree graphing for large complex populations is possible. The main limitation is the size of the pedigree printout, which could be too large to be practical.

Key Words: Pedigree, Genealogy, Visualization

W258 Spanish buck β -B inhibin/activin (INHBB) microsatellite polymorphisms. R. Realivasquez*¹, S. A. Ericsson¹, S. F. Spiller¹, W. T. Campbell¹, K. L. Sternes¹, P. H. Purdy², H. D. Blackburn², and J. M. Dzakuma³, ¹Sul Ross State University, Alpine, TX, ²USDA-ARS-National Animal Germplasm Program, Fort Collins, CO, ³Prairie View A&M University, TX.

DNA markers could be useful in selecting for potential spermatozoal fertility. The purpose of this study was to determine if β -B inhibin/activin microsatellite polymorphisms were present in Spanish buck DNA. An α (INHA) subunit and a β -B (INHBB) subunit can dimerize to form inhibin. The β -B subunit can hetero-dimerize with a β -A (INHBA) or with another β -B subunit to create activin. Inhibins impede and activins stimulate spermatogenesis through FSH regulation. Two primer sets designed for human INHBB microsatellite polymorphisms, polymerase chain reaction and electrophoresis were utilized to examine purified DNA from 23 Spanish bucks. The first primer set (forward AACAGCAA-GACCTGACTC, reverse TTAGCGTGCCATCCTCAT) showed distinctive bands located at 284 base pairs (bp) (1 hd), 282 bp (2 hd), 280 bp (14 hd), 278 bp (1 hd), or no detectable bands (5 hd). The second

primer set (forward AACTCCATCCCGGTGC, reverse ATGTGTGC-CTGTGGGTTTAG) also showed distinctive bands that were located at 248 bp (6 hd) and 246 bp (7 hd) or no detectable bands (10 hd). Significant deviation from the Hardy-Weinberg equilibrium were observed for both primer sets due to excess homozygosity. These potential polymorphic bands may imply genetic diversity, and could be used for selection strategies. Additional studies will be needed to identify specific QTL.

Key Words: Inhibin, Activin, INHBB

W259 Mapping QTL in complex pedigrees. G. Freyer*¹ and N. Vukasinovic², ¹Research Institute for the Biology of Farm Animals, Dummerdorf, Germany, ²Animal AG, Monsanto Company.

Traditional methods for detection and mapping of quantitative trait loci (QTL) in dairy populations are based on daughter design (DD) or granddaughter design (GDD). Although these designs are well established and usually successful in detecting QTL, they consider sire families independently from each other, thereby ignoring relationships among other animals in the population and consequently, reducing the power of QTL detection. In this study, we compare a traditional DD with a full pedigree design (FPD) and assess the precision and power of both methods for detecting and locating QTL in a simulated complex pedigree. The pedigree included seven large sire families with overlapping generations and inbreeding. QTL search was considered within a 54cM long chromosomal segment, covered with 11 moderately polymorphic and randomly distributed markers. Marker genotypes were available for all animals. Pedigree information was available for daughters, sires, and two generations of their male ancestors, but not for dams. Phenotypic records were available for daughters and some of the dams. One QTL was placed close to the end of the segment. QTL analyses were performed under the variance component model containing a random QTL and a random polygenic effect. The covariance matrix of the polygenic effect was a standard additive relationship matrix. The (co)variance matrix of the random QTL effect contained probabilities that QTL alleles shared by two individuals are identical-by-descent (IBD). In the DD analysis, IBD probabilities were calculated using sires and daughters marker genotypes. In the FPD analysis, IBD probabilities were obtained using a deterministic approach. Estimation of QTL position and variance components was conducted using REML algorithm. Although both methods were able to find the exact position of the QTL, the FPD method showed better precision of QTL position estimates (narrower, better defined peak) and significantly higher power (3-4 x higher test statistics) than the DD method.

Key Words: QTL Mapping, Daughter Design, Pedigree

W260 INHA microsatellite polymorphisms in Angora bucks. S. F. Spiller*¹, S. A. Ericsson¹, R. Realivasquez¹, W. T. Campbell¹, K. L. Sternes¹, P. H. Purdy², H. D. Blackburn², and J. M. Dzakuma³, ¹Sul Ross State University, Alpine TX, ²USDA-ARS-National Animal Germplasm Program, Ft. Collins CO, ³Prairie View A&M University, TX.

Genetic mediation and variability of sperm production has been hypothesized, however previous heritability estimates have always been low, therefore making selection for semen characteristics difficult. The objective of this study was to determine if α -inhibin (INHA) microsatellite polymorphisms, a dimeric subunit playing a pivotal inhibitory role in the regulation of spermatogenesis, were present in the DNA of Angora bucks. Inhibins are dimeric molecules composed of an α and one of two β subunits (βA or βB) that exert a negative feedback system on the pituitary release of FSH. Using a primer set originally developed to amplify ovine INHA microsatellite polymorphisms, purified DNA from 24 mature Angora bucks was amplified and examined using polymerase chain reaction and electrophoresis. The INHA primer set (forward primer AGCGTGTGAAGCTGGAGAT and reverse primer ACGTGATCAC-TACCACAGTACGGA) produced multiple homozygous and heterozygous banding patterns with varying numbers of base pairs (bp). Homozygous bands were detected at 195 bp (1 hd) and 200 bp (3 hd). The following heterozygous banding patterns (bp) were identified: 185, 215 (2 hd); 195, 200 (1 hd); 195, 225 (1 hd); 195, 240 (1 hd); 200, 225 (4 hd); 200, 230 (1 hd); 205, 220 (1 hd); and 205, 225 (1 hd). No banding was observed in 8 goats. This data demonstrated significant deviations of genotype counts from Hardy-Weinberg equilibrium. The presence of these INHA polymorphisms suggests a range of genetic variation that

could be utilized in selection strategies, with further work required to identify specific associations between potential markers and semen characteristics.

Key Words: Angora, Inhibin, Activin

W261 Effects of the Compact mutant myostatin allele *Mstn*^{Compact-d11Abc} introgressed into a high growth mouse line on skeletal muscle cellularity. C. Rehfeldt*¹, G. Ott², D.E. Gerrard³, L. Varga⁴, W. Schlote⁵, J.L. Williams⁶, and L. Bunger⁷, ¹Research Institute for the Biology of Farm Animals, Dummerdorf, Germany, ²University of Applied Sciences, Lemgo, Germany, ³Purdue University, West Lafayette, IN, ⁴Agricultural Biotechnology Center, Godollo, Hungary, ⁵Humboldt University, Berlin, Germany, ⁶Roslin Institute (Edinburgh), Roslin Midlothian, UK, ⁷ICAPB University of Edinburgh, UK.

The murine *myostatin* mutation *Mstn*^{Compact-d11Abc} (*Compact*; *C*) was introduced into an inbred mouse line with extreme growth (DUHi) by marker-assisted introgression. To study the allelic effects on muscle fiber hyperplasia and hypertrophy, myonuclear proliferation, protein accretion, and muscle fiber metabolism, samples from *Rectus femoris* and *Longissimus dorsi* muscles of animals wild-type (+/+), heterozygous (*C*/+), and homozygous (*C*/*C*) for the *Mstn*^{Compact-d11Abc} allele were examined by histological and biochemical analyses. *C*/*C* mice exhibited lower body (-12%) but higher muscle weights (+38%) than +/+ mice. Total muscle fiber number was increased (+24%), whereas fiber size was not affected. Protein and DNA concentrations and DNA/protein ratios as well as creatine kinase activity remained unchanged implying increases in the total contents of DNA and muscle protein. Fiber type distribution was markedly shifted to the white glycolytic (+17% units) at the expense of red oxidative fibers. Capillary density was substantially lower in *C*/*C* than in +/+ mice as seen by lower number of capillaries per fiber (-35%) and larger fiber area per capillary (+77%). However, the *C* allele was partially recessive in heterozygous mice for both fiber type frequencies and capillary density. The results show that hypermuscularity caused by mutations in the *myostatin* gene results from muscle fiber hyperplasia rather than hypertrophy, and from balanced increases in myonuclear proliferation and protein accretion. However, capillary supply is adversely affected and muscle metabolism shifted towards glycolysis, which could have negative consequences for physical fitness.

Key Words: DUHi, Muscle Fiber, Capillary

W262 Detection and characterization of microsatellite loci based on PCR. H. Y. Chung*, J. M. Ha, S. J. Oh, and S. W. Lee, National Livestock Research Institute, Omokchon.

Tri repeat microsatellite loci have been isolated based on PCR detection procedures in Korean cattle. The pooled genomic DNA samples, which were digested with Sau3A restriction enzyme, were separated onto agarose gels. DNA fragments were recovered for 3 sections (200 to 500 bp, 500 to 1000, 1000 to 1,500). A total of 6 genomic libraries were constructed by a PCR-enrichment procedure with biotined oligo probes, which were used microsatellite selection process. A total of 3,800 clones were analyzed for (ATG)_n, (TAA)_n, (GGC)_n, (CAT)_n, (GCA)_n, and (CTG)_n repeat sequences. Most clones (89%) were contained repeat regions and more than 70% clones contained single nucleotide polymorphisms. Effective clones, which contained repeat sequences that used in this study, were 45%. On the Blast search, 65% of clones were hit, 20% of clones were identified as known microsatellite loci, and 15% of clones were identified as unknown genes.

Key Words: Microsatellite, PCR, Cattle

W263 Using plasma IGF-I concentration for genetic improvement of feed efficiency in beef cattle. R. M. Herd¹, D. J. Johnston², K. Moore², H-U. Graser², and P. F. Arthur*³, ¹NSW Agriculture - Armidale, Australia, ²Animal Genetics and Breeding Unit, Armidale, Australia, ³NSW Agriculture - Camden, Australia.

Providing feed for animals is the single most expensive cost of beef production. Individual animal feed intake is difficult and expensive to measure, and this drawback highlights the need for alternative cost effective measures for genetic improvement of feed efficiency. Recent research in Australia has shown that plasma IGF-I concentration is moderately heritable (0.32 to 0.43) in beef cattle, and is genetically correlated (0.39 to

0.63) with residual feed intake (RFI), a measure of feed efficiency that accounts for differences in size and growth rate. Plasma IGF-I concentration is also genetically correlated with subcutaneous fat depth (0.35 to 0.62) and with intramuscular fat (0.26 to 0.47). The application of IGF-I for genetic improvement of livestock is now a patented technology licensed to Primegro Limited, an Australian company. For 2004, the Australian genetic improvement system (BREEDPLAN) utilised these genetic parameters to incorporate IGF-I information in the generation of estimated breeding values (EBVs) for RFI. The accuracy of EBVs for RFI generated using an animal's actual feed intake information alone is approximately 63%. While the IGF-I measure is relatively inexpensive and convenient, the EBVs for RFI generated from IGF-I information alone have low accuracies (approximately 40%). To improve accuracy, strategies that combine measurement of IGF-I in all breeding animals, and actual feed intake measurement in strategically selected individuals in the herd in a two-stage selection process will be required.

Key Words: Cattle, Feed Efficiency, IGF-I

W264 Growth hormone gene polymorphisms differentially predict ADG and carcass traits in performance tested Angus and Brangus bulls. M. G. Thomas¹, R. M. Enns², G. A. Silver^{*1}, M. D. Garcia¹, K. L. Shirley¹, V. R. Beauchemin¹, and D. M. Hallford¹, ¹New Mexico State University, Las Cruces, ²Colorado State University, Ft. Collins.

Growth hormone is necessary for growth and fat metabolism. Relationships of GH gene polymorphisms to ADG and yearling ultrasound carcass measures were evaluated in performance tested Angus and Brangus bulls ($n = 361$ from 36 sires). Bi-allelic polymorphisms were an intron 4 Msp-I RFLP (+/+, +/-, -/-) and an exon V L-leucine to V-valine single nucleotide polymorphism (SNP). Bulls were spring-born and fall-weaned and then gain tested for 112-d as they approached 1 yr of age with a ration formulated to yield 1.58 kg gain/d. Birth weight, adjusted 205- and 365-d weights, and longissimus muscle area per 100 kg of BW were similar among breed groups. Means for these traits were 37.2 ± 1.2 , 268.8 ± 11.9 , and 463.8 ± 10.2 kg and 6.2 ± 0.2 cm²/100 kg of BW, respectively. Angus bulls had greater ($P < 0.05$) ADG and ribfat thickness than Brangus bulls ($1.59 > 1.53 \pm 0.05$ kg/d and $0.66 > 0.48 \pm 0.05$ cm). Angus bulls had high frequencies (> 0.68) of the homozygous +/+ and LL genotypes, whereas genotypic frequencies were evenly distributed in Brangus bulls. Mixed model analyses revealed that the Msp-I and LV genotypes within breed were significant ($P < 0.05$) sources of variation in prediction of ADG and ribfat. The interaction between Msp-I and LV genotypes was a significant ($P < 0.05$) predictor of intramuscular fat and ribfat. In Brangus bulls, the heterozygous Msp-I genotype had the highest rate ($P < 0.05$) of ADG and the heterozygous LV genotype had the highest ($P < 0.05$) level of intramuscular fat relative to the homozygous genotypes. Concomitantly, homozygous -/- and VV genotypes had greater ($P < 0.05$) amounts of ribfat and ADG relative to the other genotypes in Angus bulls, but these genotypes were observed at very low frequencies (i.e., 0.06 and 0.03). Results suggest that GH gene polymorphisms are informative predictors of ADG and carcass measures in growing Angus and Brangus bulls. However, it appears genotypes of the two polymorphisms differentially predict these traits within the breed groups of Angus and Brangus.

Key Words: Bull, GH, SNP

W265 An improved approximation of the gametic covariance matrix for marker assisted genetic evaluation by BLUP. F. Pita^{*1}, R. Fernando², and L. Totir², ¹Newsham Genetics, LC, ²Iowa State University, Ames.

Marker Assisted Best Linear Unbiased Prediction (MABLUP) with large livestock pedigrees depends critically on efficient algorithms to invert the gametic covariance matrix for the marked QTL. These algorithms are based on tracing the QTL alleles of an individual to its grandmother or grandfather. When marker information is complete, there are simple rules to compute the probabilities (PDQs) of these events. When marker information is incomplete, even if the PDQs are computed exactly, the efficient algorithms would be approximate. Further, computing the exact PDQs becomes difficult when marker information is incomplete. In this study, we examined the effect of estimating the PDQs by MCMC on response to MABLUP. The MCMC method applied is based on the concept of segregation indicators. A pedigree with 96 individuals and four generations was simulated. Two or four bi-allelic markers were

simulated flanking a QTL which accounts for 2.85% of the genetic variation. The candidate individuals for selection did not have phenotypic information. In a previous study, use of an analytical approximation of PDQs was shown to result in a loss of about 50% of the response to MABLUP. The results of this study show that by estimating the PDQs by MCMC the loss in response was of 19.2% and 2.4% when information from 2 or 4 markers was used, respectively. Because the PDQs in this study were estimated accurately by MCMC using all available marker information, the approximation in the inverse is almost due to use of the efficient algorithm. The small loss in response that we observed here indicates that the approximation introduced through the recursive equation is small.

Key Words: Gametic Matrix, MABLUP, MCMC

W266 Identification of quantitative trait loci for carcass and growth traits in swine using principal components analysis. T. M. Stearns^{*}, S. L. Rodriguez-Zas, J. E. Beever, M. Ellis, F. McKeith, B. R. Southey, J. Hartschuh, and R. J. Feltes, *University of Illinois at Urbana-Champaign, Department of Animal Sciences.*

A three generation resource population including 832 F2 pigs was developed by a parental cross between three Berkshire grand sires and 18 Duroc grand dams. The population was genotyped for ten markers spanning 161.5 cM on chromosome 6 (SSC6), and nine markers spanning 125.5 cM on chromosome 13 (SSC13) based on a sex-averaged CRI-MAP map estimates. Animals were weighed from birth to harvest approximately every 21 d, and carcass and meat quality traits were recorded at harvest (approximately 113 kg). There were significant correlations between the 41 traits recorded and a principal component analysis was used to summarize this high dimensional data into few principal components or orthogonal linear combinations of the traits. A linear mixed effects model was used to detect QTL influencing the principal components and thus the traits of interest. The model included the fixed effects sex, birth year and month, QTL additive, dominance and imprinting coefficients, weight at slaughter and the random effect family. Genetic effects were calculated every 1 cM using a least-squares interval mapping method. The analysis identified QTL influencing groups of traits including tenth rib, last rib, and last lumbar backfat on SSC6 (group SUBFAT6); birth, 21 d, 42 d, and 63 d weight on SSC6 (group WEIGHT6) and fat %, moisture % and marbling on SSC13 (group INTFAT13). The first principal component explained 80.85%, 73.48%, and 77.85% of the variation in SUBFAT6, WEIGHT6 and INTFAT13, respectively. A QTL influencing the first principal component was detected at approximately 70 cM ($P < 0.0036$), 111 cM ($P < 0.0078$) and 87 cM ($P < 0.0009$) in SUBFAT6, WEIGHT6 and INTFAT13, respectively. The location and genetic effect estimates were consistent with univariate analysis. These results indicate that QTL mapping of many correlated traits can be enhanced by principal component analysis.

Key Words: Backfat, Weight, Marbling

W267 Chromosomal assignment of 24 candidate genes for swine efficient growth. M. Grosz^{*1}, J. Byatt¹, C. Dyer¹, K. Hinds¹, K. Eyer², and C. Beattie², ¹Monsanto Company, West Chesterfield, MO, ²University of Nevada-Reno, Department of Animal Biotechnology.

Candidate genes believed likely to be involved with growth and feed intake were used to screen a BAC library in an effort aimed at identifying chromosomal regions, and ultimately genes and mutations, responsible for phenotypic variation in efficient growth and related traits. Identified BACs were subcloned, sequenced, and primers designed for locus specific re-sequencing and SNP discovery. A subset of SNPs (filtered for sequence context, spacing, disequilibrium, and platform compatibility) were used to genotype several large, two-generation pedigrees. Linkage analysis (CRI-MAP v2.4) identified 27 linkage groups that were "anchored" to porcine chromosomes through linkage to previously assigned loci (<http://iowa.thearkdb.org/>) or assignment of loci to a porcine radiation hybrid map. The location of the putative human homolog of each gene was identified in silico and used to confirm assignments. This annotation process provided confirmatory evidence for the chromosomal assignment of 24 previously unassigned candidate genes for efficient growth. Subsequent research will now focus on aligning these genes with

QTL detected in various resource populations and comparative sequence analysis to identify functional polymorphisms.

Key Words: Swine, Growth, QTL

W268 Mapping and genetic variation within porcine 70 kiloDalton heat shock protein 2 (HSPA2). M. Grosz*¹ and G. Rohrer², ¹Monsanto Company, West Chesterfield, MO, ²USDA-ARS US Meat Animal Research Center, Clay Center, NC.

70 kiloDalton heat shock protein 2 (HSPA2) is expressed in the testis during the meiotic phase of spermatogenesis in humans and mice. Mutations in HSPA2 have been shown to cause sterility in male mice, while not affecting female reproductive capacity. Based on these comparative observations, HSPA2 is a candidate gene for influencing porcine male reproductive phenotypes. To initiate research assessing this possible relationship, the human HSPA2 sequence was used to identify a putative

porcine HSPA2 sequence from public EST databases. This EST was used to isolate a Bacterial Artificial Chromosome (BAC) clone containing the porcine homolog of HSPA2. BAC DNA was subcloned, and the porcine HSPA2 locus was defined by sequence assembly and analysis. Extant genetic variation was identified by amplification and re-sequencing of HSPA2 (and flanking regions) with a series of overlapping primer pairs. In total, 11 Single Nucleotide Polymorphisms (SNPs) and 1 single base insertion/deletion were identified in the region spanning from 1062 bases upstream of the start codon to 672 bases downstream of the stop codon. None of the identified SNPs alter the amino acid sequence of the peptide. Two SNPs were converted into PCR-RFLP assays and used to genetically map the HSPA2 locus to chromosome 7, 87 cM, consistent with the syntenic relationship between Hsa14 and Ssc7. Future research can now be directed toward detecting associations between genetic variation and swine reproductive performance and other phenotypes.

Key Words: Swine, HSPA2, SNP

Food Safety

W269 Correlation of genomic changes with morphological dimorphism of *Campylobacter jejuni*. H. Wang*¹ and M. Slavik¹, ¹POSC University of Arkansas, Fayetteville.

Campylobacter jejuni is one of the leading causes of human bacterial gastroenteritis. Previous research has shown that variation in pathogenicity of *C. jejuni* may be associated with its polymorphism. The spiral form of *C. jejuni* has been shown to be more highly pathogenic than the coccoid cells of the same strain. The objective of this research was to investigate the possibility of genomic changes associated with the polymorphism in *C. jejuni* using pulsed-field gel electrophoresis (PFGE) and DNA sequencing analysis. *Campylobacter jejuni* isolated from pre-chill, post-chill, and retail chicken carcasses and human stool samples of enteritis patients were cultured on *Campylobacter* enrichment agar for 18 hours (spiral form) and 72 hours (coccoid form) under microaerobic conditions at 42 °C. All isolates were confirmed as *C. jejuni* positive by using polymerase chain reaction (PCR). The isolates then were embedded in agarose plugs and the DNA was analyzed by PFGE (CHEF-DR III system) after digestion using either *Sma* I and *Sac* II restriction endonucleases. After an ethidium bromide staining, the DNA patterns were analyzed using the molecular analyst fingerprinting software (BIO-RAD). The molecular fingerprint of each isolate in the spiral form was compared to the fingerprint of the same isolate in the coccoid form. No genomic variation in the overall restriction patterns associated with polymorphism was observed in the strains tested. Both forms of *C. jejuni* PFGE profiles showed 100% genetic similarity following *Sma* I or *Sac* II digestion. At same time, PCR products of *flaA* gene from the isolated *C. jejuni* were purified by using Wizard PCR Preps DNA Purification System (Promega Corporation, Madison, WI). The purified DNA samples were tested for DNA sequencing analysis and the DNA sequences of each isolate in both forms were computer analyzed by using SeqMan (DNASTar inc., Madison, WI). For two forms of same isolate, the nucleic acid sequences of *flaA* gene showed 90-100% similarity. It is concluded that the morphological dimorphism of *C. jejuni* is not associated with genetic modification.

Key Words: C. Jejuni, PFGE, DNA Sequence

W270 Risk assessment for antibiotic resistance in foodborne pathogens isolated from poultry products. N. Kotrola and R. Roy*, Auburn University, AL.

Our initial goal of this study was to determine the prevalence of antibiotic resistant foodborne pathogens in poultry product samples at the retail level. 160 samples of chilled raw poultry meat (thighs, drumsticks, and breasts) and fully cooked turkey hot dogs were sampled from selected stores. One strain from each pathogen-positive sample was selected for susceptibility testing with the E-test method (AB Biodisk North America, Inc.). The E-test was performed for ciprofloxacin, tetracycline, and erythromycin according to the manufacturer's instructions. Inocula were prepared by incubating the campylobacter strains for 24 h at 42°C under microaerobic conditions in brucella broth or incubating for 24 h at 37°C in BHI broth for *Listeria monocytogenes*, *Salmonella* and *E.coli* strains. After application of the E-test strips, campylobacter plates were incubated in microaerobic conditions at 42°C for 24

h or 37 C for all other strains. The minimal inhibition concentration (MIC) was read directly from the test strip at the point where the elliptical zone of inhibition intersected the MIC scale on the strip. Our preliminary results indicated that the overall prevalence of tetracycline, ciprofloxacin, and erythromycin resistance in *Campylobacter* strains was 65.52%, 7.69%, and 7.41% respectively. The overall prevalence of tetracycline, ciprofloxacin, and erythromycin resistance in *Listeria monocytogenes* strains was 100%, 0%, and 50% respectively. The overall prevalence of tetracycline, ciprofloxacin, and erythromycin resistance in *Salmonella* strains was 100%, 0%, and 100% respectively. And finally, the overall prevalence of tetracycline, ciprofloxacin, and erythromycin resistance in *E. coli* strains was 56.25%, 0%, and 100% respectively. These initial results confirm the notion of multiresistant strains in *Campylobacter*, *Listeria monocytogenes*, *Salmonella* and *E. coli*.

Key Words: Antibiotic Resistance, Foodborne Pathogens, Poultry Products

W271 Risk Assessment of stress factors and *Listeria monocytogenes* Biofilm formation. B. Dean*, P. Mohyla, R. Roy, and N. Kotrola, Auburn University, AL.

Differential adherence capabilities and reaction to sanitizers for biofilm removal among tetracycline resistant, quaternary ammonium compound (quat), and sodium hypochlorite (bleach) stressed, acid and alkali adapted, and non-stressed *Listeria monocytogenes* (LM) were tested by the microtiter bio-screening assay. Cell turbidity and biofilm formation were assessed using a microtiter plate reader at the wavelength of 630 nm. The quantitative analysis of biofilm production was performed by adding 200 ul of 95% ethanol to destain the wells. One hundred microliters from each well was transferred to a new microtiter plate and optical densities (OD) of the crystal violet present in the destaining solution was evaluated. Viable counts were also assessed to determine the efficacy of several sanitizers for the removal of LM biofilm. Results showed significant differences in both biofilm formation and cell turbidity at 630 nm between stressed and non-stressed LM isolates ($p < 0.001$). At 630nm, bleach stressed and tetracycline resistant LM formed stronger biofilm compared to the unstressed LM with OD of -2.75×10^{-3} , -5.70×10^{-3} and 3.31×10^{-3} , respectively. There were significant difference in cell turbidity at a 630 nm, between the stressed cells compared to the positive control ($p < 0.05$), but there were no difference among the cells subjected to the various stressors. Results of the viable cell counts of the stressed LM in biofilm were significantly higher ($p < 0.05$); than the positive controls (average means of $1.8 \times 10^7 \pm 1.6$ and $4.5 \times 10^4 \pm 1.16$, respectively) when treated with sanitizers. In conclusion, stressed LM cells in biofilm appear to exhibit higher tolerance to sanitizer treatment when compared to unstressed LM cells and this tolerance may influence the efficacy of the sanitizer for biofilm removal.

Key Words: Biofilm, L. Monocytogenes, Stressed Cells

W272 Fumonisin B1 absorption study in Ussing Chamber model reveals a possible active transport. G. Casadei¹, F. Galvano², N. Chiulli¹, G. Biagi¹, and A. Piva^{*1}, ¹University of Bologna, Italy, ²University of Reggio Calabria, Italy.

Fumonisin B1 is mainly produced by *Fusarium verticillioides*, *F. moniliforme* and *F. proliferatum* that grow on cereals. As their pathogenic activity depends on bio-availability, fumonisin B1 (FB1) absorption was studied *in vitro* with Ussing chamber technique. Male rats (n=9), *Rattus norvegicus* Wistar strain, weighing 170-230g underwent laparotomy under ether anesthesia. Jejunum, starting 10cm from the ligament of Treitz was removed, cut into 2.5cm segments, and immediately immersed in a modified Krebs-Ringer buffer, oxygenated with 95% O₂ and 5% CO₂ at room temperature. Each piece was cut along the mesenteric border and mounted in Ussing chambers. The experiments started (t=0), within 30 min after the induction of anesthesia, when the buffer in the mucosal reservoirs was exchanged with 5ml buffer containing FB1 at 30ppm. At 0, 20, 40, 60, 80, 100 and 120 minutes, a 1ml sample was withdrawn from serosal reservoir for FB1 analysis, and replaced with fresh media. Of the 150mg FB1 dissolved in the 5ml mucosal solution, serosal recovery at sampling times was: 7.6%, 12.1%, 18.1%, 25.2%, 30.2%, 36.0% respectively. The apparent permeability coefficient Papp [cm/sec*10⁻⁶]=dc/dt*V/(A*Co), where dc/dt is the change in FB1 concentration on the mucosal side per unit time, V is the volume of the chamber (5cm³), A the area of exposed intestine (1.78cm²), and Co is the initial FB1 concentration in the mucosal reservoir (30ppm), was estimated to be as high as 134.3±3.7cm/sec*10⁻⁶. Regression of FB1 concentration over time revealed a linear correlation represented by the equation: y=0.412x+0.816; r²=0.9807, where y=FB1 total absorbed μg and x=minutes. According to this model, FB1 absorption in rat small intestine averages 0.232±0.007μg/min per cm² of exposed mucosa. The linearity of FB1 absorption rate seems to obey an apparent zero-order kinetic involving a carrier-mediated transport. Other studies are required to better describe intestinal FB1 uptake, so far considered to be very low.

Key Words: Ussing Chambers, Fumonisin B1, Rat

W273 Effects of fumonisin B1 on pathological and immunological parameters in pigs consuming diets with or without the addition of activated charcoal. A. Piva^{*1}, D. E. Diaz⁴, G. Casadei¹, E. Cabassi², and G. Piva^{*3}, ¹University of Bologna, Italy, ²University of Parma, Italy, ³Catholic University of the Sacred Heart, Italy, ⁴Fondazione Parco Tecnologico Padano, Italy.

Fumonisin B1 is a mycotoxin found primarily in cereals and that are produced primarily by *Fusarium verticillioides*, *Fusarium moniliforme* and *F. proliferatum*. The effects of fumonisin B1 (FB1) on weaned piglets were evaluated. Fifty-six male weaning pigs (mean initial weight of 6.9kg) were randomly assigned to pens and one of four treatments diets according to their initial weight. The treatment diets were: 1) Corn-soybean basal diet with < 2ppm FB1 (Control) 2) BD + Activated Carbon at 1% of the diet DM (AC), 3) Control+FB1 (FU) (30ppm FB1), and 4) Control+AC+FU (AC+FU). A total of 4 replicates of 3 pigs/pen for treatments 3, and 4 and 4 piglets/pen for treatments 1, and 2 were utilized. Tissue and blood samples were collected at the end of the 42-days experimental period. Pigs fed FB1 contaminated diets showed distinct lesions in lungs, heart, pancreas, spleen, small intestine and liver and had marked pulmonary edema. Animals fed the AC+FU diet had the most severe lesions in these organs and the lowest CD14 (2.61 vs 14.09; P<0.01), CD8 (4.48 vs 27.68; P<0.01) CD4 (2.29 vs 16.22; P<0.01) values compared to control. Animals fed only FB1 at 30ppm showed a reduced functionality only relative to CD14 compared (6.32 vs 14.09; P<0.01). CD4 to CD8 ratio was never influenced by the addition of FB1 (30ppm) with or without activated carbon. The consumption of diets contaminated with 30ppm fumonisin B1, from cultured material, significantly affected organ pathology and macrophage functions in post-weaned piglets. The addition of an activated carbon added at 1% of the diet was not effective in protecting, against the detrimental effects of fumonisin consumption.

Key Words: Fumonisin B1, Swine, Activated Carbon

W274 Comparison of rectoanal mucosal swabs (RAMS) and fecal culture for determining prevalence of *Escherichia coli* O157 in feedlot cattle. M. A. Greenquist^{*1}, J. S. Drouillard¹, T. G. Nagaraja², J. M. Sargeant², B. E. Deppenbusch¹, X. Shi², and K. F. Lechtenberg³, ¹Department of Animal Sciences and Industry, Kansas State University, Manhattan, ²Department of Diagnostic Medicine and Pathobiology, Kansas State University, Manhattan, ³Midwest Veterinary Services, Inc, Oakland, NE.

The lymphoid tissue in the rectoanal junction (RAJ) of the gastrointestinal tract has been suggested as the principal site of colonization of *E. coli* O157 in cattle. Samples collected by swabbing the rectoanal mucosa have been shown to be superior to fecal grab samples for detection of *E. coli* O157 in a study involving experimentally inoculated cattle and in a small number of dairy heifers. Our objective was to compare the utility of the two sampling techniques for determining prevalence of *E. coli* O157 in feedlot cattle (n = 747) fed high-grain diets. Isolation procedures included enrichment of RAMS or fecal samples in Gram negative broth with cefixime, cefsulodin, and vancomycin, followed by immunomagnetic bead separation and plating on sorbitol MacConkey agar with cefixime and potassium tellurite. Sorbitol-negative colonies were identified as *E. coli* O157 based on indole production, positive latex agglutination for O157 antigen and API 20E test strip results. Of the 82 animals that tested positive for *E. coli* O157, 87% were detected by the RAMS method, but only 45% by the fecal culture method. Genomic fingerprints of isolates were analyzed by pulse-field electrophoresis (PFGE) to compare clonal identity between RAMS and fecal isolates from the same animal. Of the 24 pairs of isolates evaluated, 20 had 100% similarity and 4 had >95% similarity in PFGE banding patterns, suggesting that strains colonizing the RAJ are the same as those isolated from feces. RAMS culture appears to be more sensitive than the traditional fecal culture method for determining prevalence of *E. coli* O157 in feedlot cattle.

Number of positive samples (% in parenthesis)

	RAMS	Fecal	RAMS of Fecal	RAMS and Fecal
Cattle, n=747	71 (9.5)	35 (4.7)	82 (11)	24 (3.2)

Chi Square test for RAMS vs. Fecal culture P < 0.01

Key Words: Rectoanal Mucosal Swabs, *E. coli* O157, Feedlot Cattle

W275 Effects of nitrate adaptation and chlorate supplementation on fecal *Escherichia coli* concentrations in Holstein steers. J. T. Fox^{*1}, R. C. Anderson², G. E. Carstens¹, R. K. Miller¹, and D. J. Nisbet², ¹Texas A&M University, College Station, ²USDA-ARS, FFSRU, College Station, TX.

In studies with broilers and pigs, bactericidal activity of an experimental chlorate product (ECP) against enteropathogens was enhanced by nitrate adaptation. Objectives of this study were to examine effects of nitrate adaptation on bactericidal activity of ECP against *E. coli* in cattle. Holstein steers (BW = 210 ± 5.1 kg) were trained to use Calan feeders and assigned to one of six treatments (n = 8) in a 2 x 3 factorial arrangement that included three ECP doses (0, 1.2 or 2.3 g chlorate ion equivalence/kg diet), with or without nitrate adaptation (0.95 g NO₃ ion equivalence/kg diet). The nitrate product (with 0 or 11% NO₃ ion equivalence) was added to the experimental diet (66, 15 and 19% corn, alfalfa hay and supplement) for 3 d immediately preceding administration of ECP (with 0, 12.5 or 25% chlorate ion equivalence), which was added one d prior to termination of the study. Fecal samples were collected prior to nitrate administration and one d following ECP administration, and cultured quantitatively for generic *E. coli*. Supplementation with nitrate and/or ECP did not affect ADG, DMI or feed:gain during the 28-d study, which averaged 1.3 ± 0.1 kg/d, 6.4 ± 0.3 kg/d and 5.2 ± 0.3, respectively. ECP did not affect DMI during the last d of the study. Initial fecal *E. coli* concentrations were not different among treatments and averaged 5.4 ± 0.2 log₁₀ CFU/g. Final fecal *E. coli* concentrations were not affected by nitrate adaptation (P = .26) or nitrate x chlorate interaction (P = .20). ECP supplementation reduced (P < .001) final fecal *E. coli* concentrations (5.2, 2.7 and 2.6 ± 0.3 log₁₀ CFU/g for 0, 1.2 and 2.3 g chlorate ion equivalence/kg, respectively), but not in a dose-dependent manner. ECP supplementation effectively reduced fecal *E. coli* by 48%, but in contrast to previous results with

broilers and pigs, nitrate adaptation did not further enhance the bactericidal effects of ECP. Rapid reduction of ruminal nitrate may account for specie differences. Discovery of nitro-compounds that are more resistant to ruminal degradation may enhance the efficacy of ECP against enteropathogens in cattle.

Key Words: *E. coli*, Chlorate, Cattle

W276 Effect of caffeine on inactivation of *Escherichia coli* O157:H7 in laboratory media. S. A. Ibrahim*, North Carolina A&T State University, Raleigh.

Escherichia coli O157:H7, a leading cause of bacterial food borne disease outbreaks, is responsible for approximately 73,500 cases of food-borne illness per year. Recent research has shown that caffeine has the ability to inhibit DNA repair in bacteria and therefore could be mutagenic compound. The objective of this research was to determine the effectiveness of caffeine on inactivation of (*E. coli* O157:H7 in Brain Heart Infusion (BHI) broth. Overnight samples of six *E. coli* O157:H7 strains (E 1730, E 4546, E 0019, Cider, 380 and 944) were used in this study. These strains were inoculated individually at an initial inoculum level of 2 log CFU/ml into BHI broth containing caffeine with different concentrations of 0.0, 0.25, 0.5, 0.75, 1.00, 1.25, 1.50, 1.75, and 2.00%. Samples were then incubated at 37 C for 24hrs. Samples were withdrawn at different time intervals to determine turbidity using spectrophotometer at 575nm. Results revealed that the addition of caffeine inhibited the growth of *E. coli*. Significant growth inhibition was observed with concentration levels 0.50% and higher. These results indicate that caffeine has potential as an antimicrobial agent and should be investigated further as a food additive to increase the biosafety of consumable food products.

Key Words: Caffeine, *Escherichia coli* O157:H7

W277 Using origanox in combination with sodium lactate and sodium acetate to inhibit the growth of *Escherichia coli* O157:H7. S. A. Ibrahim* and S. R. K. Dharmavaram, North Carolina A&T State University, Raleigh.

Escherichia coli O157:H7, a leading cause of bacterial food borne disease outbreaks, is responsible for approximately 73,500 cases of food-borne illness per year. Origanox, a commercial spice, has been shown to have antimicrobial properties. It is believed that the effectiveness of origanox can be enhanced by the use of organic acids. The objective of this research was to determine the effectiveness of origanox alone

and in combination with chemical preservatives; sodium acetate and sodium lactate on inactivation of *E. coli* O157:H7 in Brain Heart Infusion (BHI) broth. Overnight samples of five *E. coli* O157:H7 strains (E 1730, E 4546, E 0019, Cider and 944) and a mixture of the five strains were added to BHI broth at an initial inoculum level of 2 log CFU/ml. Several combinations of sodium lactate (0,1, and 2 % w/v), sodium acetate (0 and 1 % w/v), and origanox (0, 0.05 and 0.1 % w/v) were used as treatments. The samples were stored at 37 °C for 12 hrs and population changes of *E. coli* O157:H7 were followed using optical density (O.D. 610 nm) measurements and CFU techniques every two hours. Our results indicated that origanox was effective in controlling the growth of *E. coli* O157:H7 at concentration of 0.1 % in BHI broth. Sodium lactate alone was found to be effective at 3% concentration. Sodium lactate at 1-2% in combination with 0.05% origanox or sodium acetate at 1% in combination with 0.05% origanox was found to be the most effective in controlling the growth of *E. coli* O157:H7, > 4 log reduction. Treatments containing a combination of 1% sodium lactate, 1% sodium acetate and 0.05% origanox showed significant reduction of *E. coli* O157:H7, > 5 log reductions. Use of origanox at 0.05% could reduce the usage of chemical preservatives such as sodium lactate and sodium acetate to inhibit the growth of *E. coli* O157:H7.

Key Words: Origanox

W278 Selection of anti-bacterial peptides against *E. coli* O157:H7 and UTI from f88-4/15 library. C. J. Fu*, F. J. Schmidt, S. A. Mounter, and M. S. Kerley, University of Missouri-Columbia.

Phage display technology was used to select anti-bacterial peptides against pathogenic *E. coli* O157:H7 (isolates PA 1 and PA 2 from human clinical case and ground beef, respectively) and UTI (isolate PA 3 from a urinary tract infection case). After 4 rounds of affinity selection, 40 phage clones (PC 1 to 120) bearing colonies selected against each pathogen were examined. The purified phage clones were used to test their function of inhibition/killing the pathogenic *E. coli*. DNA sequencing indicated that only 2 phage sequences were repeated in 16 colonies from the PA 1 and PA 2 selection. A single clone dominated the PA 3 selection (12/16). No similar peptide sequences were found from published databases by BLAST search. Several PC (PC 5, 16, 41, 42, 46, 84, 94, and 95) inhibited or killed the pathogens (40 to 85% within 2 hours). Phage clones selected against either PA 1 or PA 2 inhibited both strains but not PA 3. However PCs selected against PA 3 inhibited PA 1 and PA 2.

Key Words: Pathogenic *E. coli*, Peptide, Phage Display

Dairy Foods: Microbiology

W279 Lactic acid fermentation by *Lactobacillus reuteri* in laboratory medium supplemented with various nutrients. S. Phetsomphou* and S. A. Ibrahim, North Carolina A&T State University, Raleigh.

Lactic acid is a product that has numerous applications in the chemical, pharmaceutical, and food industries. Lactic acid bacteria have been used widely for the production of lactic acid. However, certain nutrients are needed for the maximum production of lactic acid. Therefore, objective of this research was to investigate the effect of nutrient supplements and carbohydrate substrates on lactic acid production using free and calcium alginate immobilized *Lactobacillus reuteri*. *L. reuteri* MM 2-3 in a free cell form and calcium alginate beads (immobilized) was used to determine lactic acid production in laboratory medium supplemented with different nutrients: yeast extract, beef extract, tryptone peptone, and proteose peptone at 0, 10 and 20% concentrations or carbohydrate substrates: maltose, lactose, glucose, sorbitol and sucrose at 10% concentration. Fermentation experiments were conducted in 500 ml flasks with 300 ml final volume at 37 °C for 24 hrs. At different time intervals (2 hrs), samples were withdrawn, and analyzed for pH values and lactic acid concentrations. Fermentations of immobilized *L. reuteri* in samples containing yeast extract, phytone and proteose peptone at 20% produced the highest concentrations of lactic acid after 24 hrs with pH measurements (3.20, 3.41, and 3.61, respectively) as compared to the control (4.70). Lactic acid concentration ranged between 9.00 and

12.50. Regarding carbohydrate substrate (sugar) fermentation, maltose produced the lowest pH (3.32) followed by glucose, lactose and sorbitol (3.47, 4.00, and 6.11 respectively). Results indicated that immobilized cells of *L. reuteri* MM2-3 produced higher lactic acid and in a shorter time when compared to free cells. The results show that immobilized *L. reuteri* could be used for the production of high lactic acid concentrations in a laboratory media supplemented with both yeast extract and maltose.

Key Words: *L. reuteri*, Lactic Acid

W280 Influence of an *Arthrospira (Spirulina) platensis* biomass on acid production of lactococci. N. Molnár, L. Varga*, J. Szigeti, and B. Gyenis, Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonyaróvár, Hungary.

Arthrospira (Spirulina) platensis is a planktonic cyanobacterium belonging to prokaryotic algae. Its dried biomass typically contains 3% to 7% moisture, 55% to 60% protein, 6% to 8% lipids, 12% to 20% carbohydrate, 7% to 10% ash, 8% to 10% fiber, 1% to 1.5% chlorophyll *a*, and a wide range of vitamins. *A. platensis* has recently been marketed and consumed as a safe human food and has been approved for human nutrition by many governments, health agencies, and associations of some 80 countries, including the United States. The effect of

a spray-dried *A. platensis* biomass, on the rate of acid development by various strains of major lactic acid producers in mesophilic dairy starter cultures such as *Lactococcus lactis* subsp. *lactis* and *Lactococcus lactis* subsp. *cremoris* was evaluated in cows milk. Acid production of the starter culture strains screened was mostly stimulated significantly ($P < 0.05$), although to varying degrees. The components of the cyanobacterial biomass responsible for the stimulation observed were found to be nitrogenous compounds (peptone, adenine, and hypoxanthine). The *A. platensis* biomass rich in trace elements, vitamins, and other bioactive substrates also had a highly beneficial effect on the nutritional value of milk, thus providing a new opportunity for the manufacture of functional fermented milks, i.e., *Arthrospira*-enriched cultured cream and buttermilk.

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Key Words: *Arthrospira (Spirulina) platensis*, *Lactococcus lactis* subsp. *lactis*, *Lactococcus lactis* subsp. *cremoris*

W281 Occurrence of Glutathione sulphhydryl(GSH) and Antioxidant Activities of Probiotic Lactobacillus spp. Y. H. Yoon* and J. R. Byun, *Department of Animal Science and Technology, Chung-Ang University.*

The antioxidative ability on the basis of reduced glutathione sulphhydryl level, the inhibition activities of linoleic acid peroxidation of cell free extract of *Lactobacillus* spp and the effects of types of media and growth phase of the cells on the cellular GSH level have been determined. Correlation between reduced glutathione sulphhydryl level and antioxidative ability of *Lactobacillus* spp. was analyzed: *Lactobacillus casei* HY 2782 contained the highest level of GSH among the probiotic strains with 25.15 μ mole/g, the cellular GSH level of *L. casei* HY 2782 reached maximum after 24h of cultivation and tended to decrease on further cultivation up to 72h, it revealed significantly higher level of cellular GSH when grown in de Man Rogosa and Sharpe (MRS) broth than in tryptone phytone yeast extract (TPY) broth or bromocresol purple destroxe (BCP) broth ($p < 0.05$). The antioxidant activity of cell free extract of *Lactobacillus* spp have been shown to be significantly differed among the strains in the inhibition of linoleic acid peroxidation by thiobarbituric acid (TBA) test ($P > 0.01$). *L. casei* HY 2782 and *L. acidophilus* ATCC 4356 revealed a high degree of antioxidative effect in linoleic acid oxidation system. Spearman's rank correlation quotient between inhibitory activity on linoleic acid peroxidation and cellular GSH levels of *Lactobacillus* spp was 0.65 which means a significant positive correlation (Key words; GSH level, antioxidant effect)

Key Words: GSH Level, Antioxidant Effect

W282 Functionality and survivability of probiotics in carbonated yogurt beverage. F. Lee and M. Guo*, *University of Vermont, Burlington.*

A prototype carbonated yogurt beverage was developed using a probiotic yogurt as a base and carbonated with 0, 1, 2 or 3 volumes of food-grade carbon dioxide. Inulin (natural prebiotic ingredient) and probiotic bacteria were integrated into the product to create a symbiotic dairy beverage that could benefit the health of consumers. Mean chemical composition of the beverage from all 3 trials consisted of 16.3% total solids, 14.6% carbohydrates, 2.2% protein, 1.7% fat and 0.2% ash. Mean content of Ca, P, K, Mg, Na, Cu and Zn in the beverage were 745, 380, 671, 50, 222, 0.2 and 13 mg/kg, respectively. Mean pH values of the beverage carbonated with 0, 1, 2 and 3 vol of CO₂ during the 10-wk study were 3.58, 3.70, 3.59 and 3.56, respectively. Averaged viscosity values of the beverage for the same treatment and period were 26.3, 24.0, 25.3 and 21.1 mPa.s, respectively. Visual inspection and negative results from 3M yeast / mold and coliform films indicated the beverage remained stable up to ten weeks in refrigerated storage. Survivability of probiotic bacteria in the beverage during a 10-wk study was evaluated according to enumeration methods of Chr Hansen, Inc. Initial estimated levels of *L. acidophilus* in the beverage carbonated with 0, 1, 2 and 3 vol of CO₂ were 7.4, 6.8, 6.9, and 7.3 log CFU/ml, respectively. Correspondingly, initial levels for *Bifidobacteria* were 7.2, 7.3, 7.3 and 9.0 log CFU/ml; and 7.7, 7.9, 8.0 and 8.1 log CFU/ml for *L. casei*. Levels of *L. acidophilus* in the beverage decreased below 6.0 log cfu/mL shortly after week 4, regardless of carbonation levels. Population of *Bifidobacteria*

gradually decreased and remained above 6.0 CFU/ml through week 10 in beverages carbonated with 2 and 3 vol CO₂. Levels *L. casei* of also decreased steadily but remained above 6.0 CFU/ml only through week 8 in all carbonated beverages. In summary, carbonated symbiotic yogurt beverage can be developed to deliver probiotic bacteria. Carbon dioxide may have positive impact on the survival of certain probiotics, i.e., *Bifidobacteria*.

Key Words: Yogurt, Beverage, Probiotic

W283 Influence of bile salts on growth, antimicrobial activity and β -galactosidase activity of *Lactobacillus reuteri*. S. A. Ibrahim* and S. A. Ahmed, *North Carolina A&T State University, Raleigh.*

It is well known that the presence of lactobacilli is important for the maintenance of the intestinal microbial ecosystem. They have been shown to possess inhibitory activity toward the growth of pathogenic bacteria such as *Escherichia coli* O157:H7 and *Salmonellaspp*. This inhibition could be due to the production of inhibitory compounds such as organic acids, hydrogen peroxide, bacteriocins, or reuterin or to competitive adhesion to the epithelium. In order to survive in and colonize the gastrointestinal tract, lactobacilli should express high tolerance to acid and bile. They should have the ability to adhere to intestinal surfaces and produce large quantity of β -galactosidase. The purpose of this work was to investigate the influence of bile salts on growth, antimicrobial activity and β -galactosidase activity of *Lactobacillus reuteri*. Six strains of *Lactobacillus reuteri* (CF 2F, DSM 20016, MF 14C, MM 7, MM 2-3, and SD 2112) were used in this study. These strains were grown in modified Trypticase-protease peptone-yeast extract (TPY) broth containing 0.0 or 0.4% bile salt at 37 C for 48 hrs. The extent of bacterial growth was monitored by measuring the optical density of the samples at 610nm after various time intervals. The effect of bile salt on the production of antimicrobial compounds was tested using the diffusion assay. The β -galactosidase activity was determined during the growth in the presence of bile salt. Results showed that growth and antimicrobial activity decreased in the presence of 0.4% bile salt ($P < 0.05$). The β -galactosidase activity was varied among the tested strains. MM 2-3 showed higher β -galactosidase in the presence of bile salt. Activity ranged between 800 and 1400 Miller units. Bile salt does not affect β -galactosidase activity of MF 14C strain. Our results demonstrate that bile salt has an influence on the biochemical properties of *Lactobacillus reuteri*. Bile salt should be considered when probiotic strains are selected for useful industrial applications.

W284 Incidence of *Escherichia coli* O157:H7 in raw milk and survival of a five strain cocktail of *E. coli* O157:H7 during the 60 days aging period of hard cheese made from unpasteurized milk. J. Schlessner*¹ and R. Gerdes², ¹*Food and Drug Administration, NCFST, Summit-Argo, IL,* ²*Illinois Institute of Technology, Summit-Argo, IL.*

The incidence and concentrations of *E. coli* O157:H7 present in raw milk as delivered to Midwest milk processors were determined. For incidence, raw milk were inoculated in pre-enrichment and enrichment broths and incubated before plating. One ml samples of raw milk was pipetted onto 2 BCM plates and incubated for determination of concentration of the pathogen. All 237 samples tested were less than the lower limits of detection for incidence and concentration. Hard cheese was made from unpasteurized milk inoculated with 10¹ cells/ml of a five-strain cocktail of acid-tolerant *E. coli* O157:H7. 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 10² in the drained curd and to 10³ at milling and pressing. Population of *E. coli* O157:H7 in cheese aged for 60 and 120 days at 7 ° C, decreased less than 1 log and 2 logs, respectively. After 150 to 180 days, levels declined to <1/ml. Cheese samples in storage were inoculated in pre-enrichment and enrichment broths and incubated before plating. After approximately 240 days, no growth of

E. coli O157:H7 was seen on the plates after either pre-enrichment or enrichment.

Key Words: Raw Milk Cheese, *Escherichia coli* O157:H7, *E. coli* O157:H7 in Raw Milk

W285 Incorporation and survival of probiotic bacteria in yogurt for use as a functional food. S. Hekmat^{*1}, S. Royal^{2,3}, and G. Reid^{2,3}, ¹Brescia University College at The University of Western Ontario, London, Canada, ²The University of Western Ontario, London, Canada, ³Lawson Health Research Institute, London, Ontario, Canada.

Both *Lactobacillus fermentum* RC-14 and *Lactobacillus rhamnosus* GR-1 have been shown to be probiotic agents with intestinal and urogenital therapeutic properties, and both colonize the intestine when ingested in skim milk. Low-fat (1%) probiotic yogurt was made by fermenting standard yogurt starter cultures, *L. delbrueckii var bulgaricus* and *S. thermophilus*, mixes with *L. fermentum* RC-14 and *L. rhamnosus* GR-1. Survival of *L. fermentum* RC-14 and *L. rhamnosus* GR-1 was monitored using selective MRS agar containing 50 µg/mL tetracycline or 15 µg/mL fusidic acid, respectively, after 1, 7, 14, 21, and 28 days of storage at 4°C. In all treatments, *L. rhamnosus* GR-1 survived better than *L. fermentum* RC-14. After one day of storage, mean colony counts of *L. fermentum* RC-14 and *L. rhamnosus* GR-1 were 7×10^5 and 4×10^7 CFU/mL respectively. After one month of refrigerated storage, these counts had decreased to 4×10^3 for RC-14 but remained stable at 2×10^7 CFU/mL for strain GR-1. This study provides a method to derive a new probiotic yogurt as a vehicle to deliver beneficial bacteria to consumers. Such a yogurt, with high counts of probiotic bacteria, would be the first of its type in Canada.

Key Words: Functional Foods, Probiotic Yogurt

W286 Development of probiotic concentrated yogurt using direct reconstitution method. S. Hekmat*, V. W. Y. Ng, and A. J. Holman, Brescia University College at The University of Western Ontario, London.

Concentrated yogurt is traditionally made by draining the yogurt in a double layer cheese cloth bag. This process is time consuming and may introduce unwanted microorganisms into the yogurt through contamination. The objective of this study was to produce probiotic concentrated yogurt by direct reconstitution method. Full-fat milk powder and non-fat milk powder were reconstituted with either water or milk to 12, 16, 18, 20, 23, and 26% total solids (TS). Some of the samples contained 0.3% or 0.6% gelatin. The mixtures were heat treated at 85°C for 30 min., cooled to 41°C, and then inoculated with 4% of the starter yogurt cultures containing *Lactobacillus acidophilus* and *Bifidobacterium bifidum*. The mixtures were stirred well and fermented for approximately 5 h at 42°C until the desired pH was reached. The samples that were reconstituted with milk did not ferment at all. The samples with 20 and 23% TS containing full-fat milk powder and 0.3% gelatin resulted in the best quality in terms of appearance, flavour, texture, and overall quality.

Key Words: Concentrated Yogurt, Probiotic Yogurt

W287 Suitability of *Kluyveromyces* spp. for use in single-cell protein production from sweet cheese whey. B. Ásványi, J. Szigeti, and L. Varga*, Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.

Only 51.2% of liquid whey produced in the United States is further processed into food or feed ingredients. An alternative to the traditional uses of whey is the production of single-cell protein (SCP). In this study, the suitability of the strains of two *Kluyveromyces* species (i.e., *K. marxianus* var. *marxianus* LAF4 and *K. lactis* KE 231) for use in SCP production was examined. The major parameter measured was the dry weight of the yeast biomass. The *Kluyveromyces* strains tested were grown in unfractionated, heat-treated sweet cheese whey. Fermentations were run batchwise for 48 h in an automated BIOFLO III[®] batch/continuous fermenter under identical conditions with respect to pH, aeration, and agitation rate. The parameters set were computer-controlled using Advanced Fermentation Software[®] version 3.42. Samples were taken every 4 h with an MX3 Biosampler[®]. After proper

centrifugation and drying, the dry weight of yeast biomass was determined. The lactose, glucose, galactose, and ethanol contents of samples were also measured. *K. marxianus* var. *marxianus* LAF4 was shown to be superior in terms of suitability for production of SCP from sweet cheese whey to *K. lactis* KE 231 under commercial conditions.

Key Words: Single-Cell Protein, *Kluyveromyces* spp., Whey

W288 Ethanol metabolism by probiotic lactic acid bacteria *in vivo*. W. Y. Yang^{*1}, Y. T. Ahn², K. S. Lim², C. S. Huh², Y. J. Baek², and H. S. Kim¹, ¹Culture Systems, Inc., Mishawaka, IN, ²Korea Yakult Co., Ltd, Kyunggi do, South Korea.

Recent studies have shown that probiotic lactic acid bacteria have alcohol dehydrogenase (ADH) and acetaldehyde dehydrogenase (ALDH) activities. However, little is known about the metabolism of ethanol and acetaldehyde *in vivo*. The aim of this study is to test the possibility that probiotic lactobacillus strains are able to metabolize ethanol and acetaldehyde *in vivo*. Four *Lactobacillus* spp. and one *Bifidobacterium* spp. were used for this experiment. Male Swiss Webster mice weighing between 19-21 g were used for *in vivo* experiments. The lactic acid bacteria of 10^9 cfu/ml were delivered orally once a day to the mice for 30 days. Ethanol, diluted in water (25:75; v/v), was administered once a day by gastric intubations for 30 consecutive days. The average daily consumption of ethanol was 12 g/kg body weight. Concentrations of ethanol and acetate *in vivo* were measured with HPLC. The acetaldehyde concentration was analysed by head-space gas chromatography. All lactic acid bacteria were able to metabolize ethanol *in vitro*, with *Lactobacillus fermentum* CS332 exhibiting the highest degradation of ethanol. There was an increase of ethanol breakdown in the jejunum and colon of the mice treated with *L. fermentum* CS332. Ethanol content was 18.2% less in the jejunum and 32.9% less in the colon. Its ability of acetaldehyde conversion into acetate was also significantly higher than the control (P<0.05). The breakdown of ethanol and the conversion of acetaldehyde into acetate were observed in mice intestines by lactic acid bacteria after ethanol intake. Based on these data, we suggest that lactic acid bacteria have a beneficial impact on degradation of ethanol and acetaldehyde following heavy drinking.

Key Words: Lactic Acid Bacteria, Ethanol Metabolism

W289 Effects of proteolytic starter cultures on melt characteristics of low moisture part skim (LMPS) Mozzarella cheese. S. Das* and R. I. Dave, South Dakota State University, Dairy Science Department, Brookings.

The study assessed the feasibility of using selected starter cultures and different types and levels of coagulating enzyme for making LMPS Mozzarella cheese with desired functionality. LMPS Mozzarella cheeses were made from cows milk standardized to 1.8% fat made with four different types of starter cultures comprising *Streptococcus thermophilus* (ST), *Lactobacillus helveticus* (strain SH-Z or L-11), and *Lactobacillus delbrueckii* ssp. *bulgaricus* (LB-12). Cheeses were made with ST and combination of ST and SH-Z, ST and L-11 or ST and LB-12. Rennet and *Cryphonectria parasitica* (CP) were used at two different levels (1X or 6X) as coagulating enzymes. Cheeses were analyzed for fat, protein, moisture, total solids, calcium, salt, and ash on day 1. Changes in melt characteristics and proteolysis during storage (4°C) were monitored on 1, 7, 15, and 30 days (d). Meltability of cheese as measured by modified Schreiber test showed differences for cheeses made with different types of starter cultures, and also for different types and level of coagulating enzymes. Cheeses made with ST + SH-Z with coagulant CP at 6X level of enzyme resulted in highest melt area. Softening time and temperature, and melting time and temperature as measured by melt profile analysis were also significantly effected by the type of starter cultures and storage period. Extent of flow and flow rate were higher for ST + SH-Z cheeses and increased further upon 4°C storage of 30 d. Soluble protein as measured by 12% TCA also increased during storage and was highest for cheeses made with ST + SH-Z with coagulant CP at 6X level of enzyme. As the aging progressed, faster breakdown of intact caseins by CP and proteolytic lactobacilli SH-Z took place resulting in a faster weakening of the protein matrix of the cheese, which in turn translated into favorable changes in functional characteristics, especially meltability. LMPS Mozzarella cheese made with proteolytic

culture along with CP has a clear advantage to cheese manufacturers and end users to achieve the desired melt properties in cheese.

Key Words: Mozzarella Cheese, Melt Characteristics, Starter Cultures

W290 Exo-polysaccharides production in whey mineral concentrate. N. Pandya*¹, R. Dave¹, A. Hassan¹, and L. Metzger², ¹Dairy Science Department, South Dakota State University, ²Food Science and Nutrition Department, University of Minnesota, St. Paul.

The use of whey mineral supplements in neutral pH beverages such as tea and coffee has been limited due to its poor solubility and gritty mouthfeel. Neutral and phosphorylated exopolysaccharides (EPS) produced by Lactic acid bacteria (LAB) have the potential to improve the solubility and reduce the gritty mouthfeel of whey mineral concentrate since they can function as a nucleation site for the formation of calcium phosphate micro-granules. The growth of two EPS-producing bacterial cultures (*Lactobacillus helveticus* or *Lactococcus lactis* subsp. *cremoris*) in whey mineral concentrate (WMC) with 5, 7.5 and 10% total solids was studied during a 24 h incubation period. Both cultures propagated in 11% reconstituted skim milk were inoculated in to WMC at 2% (v/v) rate and incubated at 37°C for *Lactobacillus helveticus* and at 25°C for *Lactococcus lactis* subsp. *cremoris*. The samples were analyzed for titratable acidity, pH and microbial counts at 4 h interval for 24 h. Viscosity of the fermented WMC at 20°C was measured after 24 h of incubation and overnight cooling (7°C). Both cultures produced EPS at all the 3 solids level, which was evident from fluorescence microscopy observations, the ropiness produced and increase in apparent viscosity of WMC. The viscosity increase was approximately 3 fold with *Lactobacillus helveticus* and approximately 2.4 fold with *Lactococcus lactis* subsp. *cremoris*. The growth pattern, rate of drop in pH and rate of increase in acidity were almost similar at all total solids level. Also, for both cultures, there was no significant (P<0.05) difference in the viscosities of WMC at all solids level studied. It was concluded that WMC could support the growth of both EPS-producing cultures and their EPS production was higher in WMC at low solids level. *Lactobacillus helveticus* is recommended due to its ability to produce higher viscosity.

Key Words: Exopolysaccharides, Whey Mineral Concentrate, Lactic Acid Bacteria

W291 Modification of sweet whey for the growth of *Bifidobacterium bifidum*. H. Hernandez-Sanchez*, M. L. Mier-Espinosa, and M. T. Cruz y Victoria, *Escuela Nacional de Ciencias Biológicas - Instituto Politécnico Nacional*.

Sweet whey has been used on a large scale for different biotechnological processes including the manufacture of food and beverages. The purpose of this work was to study the modification of this cheese byproduct for the growth of the probiotic microorganism *Bifidobacterium bifidum*. The modification was done in two stages: first, hydrolysis with two plant proteases and second, thermal treatment at pH 11. For the whey protein hydrolysis, the raw extracts of two proteases from Mexican plants were assayed using the sweet whey (pH 6) as substrate: mexicanin from the cuaguayote fruit (*Pileus mexicanus*) latex and hemisphericin from the timbirichi fruit (*Bromelia hemisphaerica*) juice. The thermal treatment was done with whey whose pH had been adjusted to 11. Temperatures of 60, 70 and 80°C for 15 and 20 min were used in this experiment and the resultant wheys analyzed to detect the formation of lactulose, which is known to stimulate the growth of bifidobacteria. The effect of the modification treatments was followed by inoculating the wheys with *Bifidobacterium bifidum* and registering the growth after 18 h of incubation under anaerobic conditions at 37°C. The activity of hemisphericin was higher on the whey proteins than that of mexicanin. When 1% protein sweet whey was used as substrate, 82 530 activity units were obtained with hemisphericin at 35°C after a 4 h incubation period. The highest lactose to lactulose conversion was obtained after 15 min at 80°C with a final concentration of 1.6 g/L of lactulose in the whey. These two conditions were used for the whey modification. After the fermentation processes, the following final counts were obtained: 1 X 10¹⁴, 1.7 X 10¹⁴ and 6.4 X 10¹⁴ CFU/ml for the untreated whey, hydrolyzed whey and hydrolyzed and heated whey respectively. The results show that when

both modifications (enzymatic and thermal) were applied to the sweet whey, the counts of the bifidobacteria were up to 6.4 times higher than those of the unmodified whey. This indicates that these modifications could be useful in the production of probiotics or functional beverages.

Key Words: Whey, Probiotic, Bifidobacteria

W292 Optimization of fermentation conditions for development of environmentally friendly deicer. L. Zhang, S. Gokavi*, J. Li, and M. Guo, *University of Vermont, Burlington*.

Sodium chloride is the commonly used deicer for road management and safety during winter in Vermont and other Northern states. Studies showed that environment is adversely affected by the salt. Whey containing lactose accounting for 90% of its total solids is a byproduct of cheese making and its disposal poses a negative impact on the environment. The objective of this study was to optimize the fermentation conditions to develop an environmentally friendly deicer from whey. Lactic acid bacteria (LAB) from our culture collection were studied for production of lactate from lactose. Among them *Lactococcus lactis* produced lactate at pH 7.0-7.6. *Clostridium formicaceticum* (27076) was used to produce acetate from lactate at pH 7.3-8.0. Combinations of different LAB and acetogen were studied for production of acetate from lactose in whey permeate (WP). Combination of *Lactococcus lactis* and *Clostridium formicaceticum* produced lactate and acetate and the concentration of acetic acid (AA) after 60-72h was 1.6-2.1% which was increased to 1.8-2.5% by supplementing selected nutrients. The cultures were made lactate and acetate tolerant by growing the cultures in WP having high salt concentration (4%) and isolating and subculturing them. The substrate was optimized by adding 5% tomato juice, 0.1% malt extract, 0.2% ammonium phosphate, 0.2% yeast extract, 0.2% peptone and 0.35% vitamin solution to 5% WP powder as it did not support growth in its pure form. The optimum conditions to ferment this substrate by inoculating 10% of culture were temperature 37°C-39°C, pH 7.3-7.6 maintained using 4M potassium hydroxide, anaerobic condition maintained using nitrogen gas supplied at 1-2 psi, agitation speed 100 rpm and time 84-96h using continuous flow cell-recycle fermentation in a bioreactor. The AA and potassium acetate production was 3.5-4.2% and 5.7-6.9%, respectively and the culture population reached OD 1.6-1.8 at 660 nm. In conclusion, continuous flow cell-recycle fermentation with optimum conditions could be used to increase the yield of AA and/or potassium acetate.

Key Words: Deicer, Potassium Acetate, Whey

W293 Extraction of acetic acid from fermented whey permeate broth. L. Zhang, S. Gokavi, J. Li*, and M. Guo, *University of Vermont, Burlington*.

A combined anaerobic fermentation process was developed to produce potassium acetate (PA) from cheese whey. PA can be used as an organic and environmentally friendly deicer. A coculture consisting of homolactic and heterolactic bacteria was used to convert whey lactose to lactic acid and then to acetic acid (AA) in a bioreactor. The AA is extracted using liquid-liquid reactive extraction to produce potassium acetate. A series of extraction tests was carried out to determine the best solvent and conditions for AA extraction from fermented broth. The broth was adjusted to have pH 3.5, 4.7, 5.9, 7.1 and 8.3 and treated with an equal volume of best extraction solvent Alamine 336 and 2-octanol (1:1). The amount of AA extracted at pH 3.5, 4.7, 5.9, 7.1 and 8.3 was 63.5%, 59.7%, 60.9%, 53.0% and 12.0% respectively. The extraction efficiency (EE) was higher when broth contained K⁺ (66.0%) and Na⁺ (61.0%). NH₄⁺ lowered the EE (7.8%). There was no significant difference between EE in presence of anions SO₄²⁻ or Cl⁻. So it is recommended to use sodium hydroxide or potassium hydroxide to neutralize the pH and hydrochloric acid to decrease pH. EE was 62.8% when the ratio of extractant to broth was 1:1, 46.44% when 2:1 and 42.18% when 1:2. EE was 62.8% when the ratio of extractant to diluent was 50:50, 50.2% when 70:30 and 47.6% when 30:70. The results showed that extraction of acetic acid from whey permeate fermented broth was highest when ratio of Alamine 336 to 2-Octanol was 1:1 and pH 3.5.

Key Words: Acetic Acid, Liquid-Liquid Dxttraction, Potassium Acetate

W294 Evaluation of modified M17 broth for growth of *Lactobacillus reuteri* and *Bifidobacterium* sp. S. A. Ahmed* and S. A. Ibrahim, North Carolina A&T State University, Raleigh.

International dairy federation (IDF) recommends M17 broth for starter lactococci and streptococci and MRS broth (DeMan Rogosa sharpe) for starter Lactobacilli growth. M17 broth medium with specific modifications could be utilized for growth of selected *Lactobacillus reuteri* and *Bifidobacterium* sp. as a convenient medium that can be used easily by the industry in a routine fashion. The objective of this study was to evaluate the ability of modified M17 to promote the growth of *Lactobacillus reuteri* and Bifidobacteria. Six strains of *Lactobacillus reuteri* (DSM20016, MM2-3, MM7, SD2112, CF2-7F, and MF14-C) and four strains of *Bifidobacterium* sp. [*B. infantis*(ATCC 15697, ATCC 15702, ATCC 25962), and *B. longum* 79] were used in this study. The modified M17 broth was prepared by adding M 17 37.25 g/L, Beef extract 5.0g/L, yeast extract 2.5 g/L, and peptone from casein 5.0g/L. Glucose solution (20.0 g/100 ml) was autoclaved separately and added to the autoclaved modified M17 broth. Overnight cultures were centrifuged and washed twice with peptone water. Strains were inoculated into fresh M17 and modified M17 broth, then mixed well and incubated at 37 °C for 24 hrs during incubated period the bacterial growth was monitored using spectrophotometer at 610 nm. At (0.0, 12, and 24hrs). After 24 hrs all tested strains were plated on MRS agar to obtain microbial population. Results showed that higher microbial growth was observed in all tested strains using the modified M 17. The optical density in the modified M 17 reached over 1.30 while it reached only 0.70 in the original M 17. The bacterial population increases by at least 1 logcfu/ml. Modified M17 could be a good growth medium in quality control laboratories for general purpose of bacterial growth of lactic acid bacteria and probiotics.

Key Words: M17 Broth, *Lactobacillus reuteri*, *Bifidobacterium*

W295 Effect of dietary whey protein and *Lactobacillus Casei* ATCC 393 on the change of lymphocytic cell population in rats. H. J. Lim*, J. G. Kim, H. Y. Oh, S. H. Kim, and K. Y. Whang, Korea University, Seoul Korea.

Seventy-five male Sprague Dawley rats (195.26 ± 3.45 g) raised according to the guideline of NRC (1996) were divided into five groups. A commercial murine diet (NIH-31M) was used as a basal diet. Experimental diets used in this experiment were: 1) basal diet (Cont), 2) basal + 1% whey protein concentrates (WPC), 3) basal + 1% live *L. casei* 393 (LLAB), 4) basal + 1% dead *L. casei* 393 (DLAB), 5) basal + 0.5% whey protein concentrates and 0.5% dead *L. casei* 393 (W+D). Both live and dead *L. casei* 393 cultures contained 10¹² cfu/g. After feeding each experimental diet for two weeks, rats of each group were subjected to inoculating with 0.2 mL of influenza hemagglutinin peptide (HIN1, 60 µg/mL) via intramuscular injection. Blood samples were collected prior-inoculation (day 0) or at days 10 and 15 of post-inoculation. Red blood cells of samples were lysed and each sample was incubated with specific antibodies against surface antigens of lymphocyte (CD3, CD4, CD8 and CD45R). Three different types of lymphocyte (CD3+/CD4+ Th-cell, CD3+/CD8+ Tc-cell and CD3-/CD45R+ B-cell) were sorted by FACS analysis. After inoculation, T-cell population was found to significantly increase in all groups, with highest level in WPC and lowest level in LLAB at day 10 (P < .05). The B-cell populations of WPC, DLAB and W+D groups were shown to increase at day 15 compared with days 0 and 10. In contrast, the B-cell population of LLAB group showed highest at day 10, and then decreased at day 15. In conclusion, it is plausible that supplementation of whey protein and *L. casei* 393 increases humoral immunity and dietary live *L. casei* 393 stimulates immune response more rapidly than others.

	B-cell		T-cell			
	Day 0	Day 10	Dat 15	Day 0	Day 10	Day 15
Cont	10.57	11.01 ^{ab}	11.00	23.29 ^b	48.89 ^{ab}	45.29
WPC	9.50	13.03 ^{ab}	20.12	16.09 ^c	57.27 ^a	43.94
LLAB	8.85	16.09 ^a	14.15	17.85 ^{bc}	40.43 ^b	36.90
DLAB	8.71	8.76 ^b	15.22	17.23 ^c	48.88 ^{ab}	37.09
W+D	10.13	8.87 ^b	14.39	30.20 ^a	46.59 ^{ab}	40.23
SEM	2.16	1.73	2.30	1.84	2.61	2.76
P-value	NS	0.04	NS	0.01	0.02	NS

Key Words: Whey Protein, Lymphocytes, Rats

W296 Viability of *Bifidobacterium longum* and *Lactobacillus reuteri* in sour cream. S. A. Ibrahim and E. D. Wilson*, North Carolina A&T State University, Raleigh.

Over the past two decades the consumption of probiotic products has risen considerably. This is mainly due to the large amount of scientific evidence from human studies, which demonstrate that regular probiotic consumption helps in maintaining a healthy digestive tract. In order for probiotics to be included in dairy food products, they should be in viable quantities for the duration of the shelf life. Therefore, the objective in this research was to determine the viability of probiotic, *Bifidobacterium longum* and *Lactobacillus reuteri* in commercially-available sour cream. Fresh sour cream samples were obtained from a local market and inoculated with one of the following probiotic strains: *B. longum* (ATCC 5708 and NCFB 2254) *L. reuteri* (MM 2-3 and MM 7) and to obtain a final inoculum level of 10⁷cfu/ml. The sour cream samples were then mixed thoroughly and refrigerated at 4 °C for 2 weeks. The samples were analyzed for viable bacterial count using modified BIM 25 agar to enumerate bifidobacteria and MRS agar supplemented with 50 µg/ml vancomycin to enumerate lactobacillus. Our results show that although bacterial counts decreased, the products contained an average 5.0 x 10⁵ cfu/ml of viable probiotics after 15 days of storage. Results also show significant differences (P<0.05) among the tested strains during the storage period. Both *B. longum* strains had two log reduction while *L. reuteri* MM 7 had one log reduction over the storage period. *L. reuteri* MM 2-3 shows a slight decline although it was not significant over the storage period. Our results show that the concept of using sour cream as a probiotic carrier is a feasible application for use in the food industry.

W297 Yogurt development from camel milk. I. B. Hashim* and A. H. Khalil, United Arab Emirates University, Al-Muhandeseen - Giza.

The camel (*Camelus dromedarius*) has the ability to produce more milk for longer period in arid zones and dry lands. Although camel milk has been used to produce acceptable feta-type cheese, hard cheese and ice-cream, it exhibits antibacterial properties causing problems in fermentation. The rheological and microscopic characteristics of the dromedary milk have shown that its coagulum to be a fragile, heterogeneous curd structure which fails to gel with lactic acid cultures. The objectives of this study were to develop yogurt from camel milk and to determine its sensory characteristics. Yogurt was prepared from cow and camel milk using standard procedure following a commercial yogurt formula [2.5% milk solid nonfat (MSNF), 0.6% commercial stabilizer (CS) and commercial yogurt culture (CYC)]. Yogurt made from camel milk using up to double the amount of the ingredients used for yogurt making (MSNF, CS and CYC) produced viscous yogurt with fragile texture. Addition of carboxy methyl cellulose had no significant effect on yogurt texture while addition of gelatin, sodium alginate (ALG) and calcium chloride (Ca) improved yogurt texture. Sensory profile of yogurts conducted by five trained experienced panelists showed that yogurt containing 1% gelatin or 0.75% ALG + 0.075 % Ca had the best texture. Hedonic ratings by 33 consumers indicated that yogurt made from camel milk using 0.75% ALG + 0.075 % Ca had similar sensory ratings and acceptability (6.0-7.6) as yogurt made from cow milk (6.4-7.9). Fruit yogurt prepared by adding 15% fruit concentrates of various mixtures to camel milk containing (0.75% ALG and 0.075 % Ca) had similar hedonic ratings and acceptability. Production of yogurt from camel milk will enable

many arid regions populations to make use of surplus camel milk with potentials for marketing such products.

Key Words: Camel Milk, Yogurt, Consumer Acceptance

W298 Physico-chemical and sensory properties of liquid-type yogurt with *Lactobacillus casei* 00692. B. J. Jeon*, J. S. Seok, and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was carried out to find the physico-chemical and sensory attributes of liquid-type yogurt with *Lactobacillus casei* 00692 during 72 hr fermentation at 37°. The pH decreased upto 32 hr and plateaued thereafter, and the titratable acidity increased upto 40 hr. The growth

of lactic acid bacteria sharply increased with 9.0×10^9 cfu/ml upto 36 hr of fermentation and slowly increased thereafter. The free amino acids produced during the fermentation reached the maximum value at 40 hr and gradually decreased thereafter. In the result of electrophoresis, the band was the thickest at 44 hr and mostly disappeared at 72 hr fermentation. In a sensory analysis, yogurt flavor was gradually developed during 30 hr, while bitterness score did not significantly changed throughout fermentation periods. The present data showed that the range of optimum fermentation time for liquid-type yogurt using *Lactobacillus casei* 00692 was from 40 to 44 hr.

Key Words: Fermentation Time, Liquid-Type Yogurt, *Lactobacillus casei*

International Animal Agriculture

W299 Utilization of *Leucaena leucocephala* as supplement for goats in the semi arid areas of Venezuela. T. Clavero* and R. Razz, *La Universidad del Zulia, Venezuela.*

A field experiment was conducted in the dry land farming area of north-west Venezuela in order to evaluate three diets in grazing goats (grazing pasture only (buffel grass); grazing pasture + 0.3 kg of commercial concentrate/animal/d; grazing pasture + restricted browsing for two hours daily *Leucaena leucocephala*) on milk production and milk composition. The experiment was laid out randomized block design. The data showed significant difference ($P \leq 0.05$) between treatments. Daily milk yield increased in 35 and 52.7% when goats had access to commercial concentrate or browsing *Leucaena* as well as grass pasture compared with the control treatment. Daily milk yield in goats with access to *Leucaena* was insignificantly different than goats on concentrate. Treatments did not affect milk composition. The results suggest that *Leucaena* can supply an adequate amount of nutrients with similar value to commercial concentrate for milk production without adverse effects on tropical grazing goats.

Key Words: *Leucaena leucocephala*, Goat, Milk Production

W300 Estimation of genetic and phenotypic parameters of total milk production in Suran Holstein dairy farm. S. Zakizadeh, A. Horufi*, and M. Qolipur, *High Education center of Jihad & Agriculture.*

Most traits of economic importance in animal breeding are quantitative in nature. The phenotypes observed are thus the combined results of the action of many genes or quantitative trait loci and environmental effects. As the selection of dairy cattle is focused on the improvement of yield and composition of milk, the object of this research was to estimate genetic parameters and breeding values of total milk production in a Holstein dairy farm in the northeast of Iran. The data used from Animal Breeding Center of Iran and consisted of total milk records from 2247 cows, between 1990 and 2003. Base population was imported from Canada and the Netherlands in 1990. To investigate environmental effects, following model was analyzed in JMP 3.1.2 Software. The model included random effects of sire and dam, lactation and calving year as fixed effects, calving interval, peak of yield, and days in milk as covariates. All factors were significant ($p < 0.05$). It was concluded that the highest milk production would be achieved in the 4th lactation. Animal model procedure was used to estimate genetic parameters and breeding values by DF-REML software. Heritability and repeatability coefficients were 0.2 and 0.36 respectively.

Key Words: Total Milk Production, Genetic and Phenotypic Parameter Estimation, Milk Production Heritability

W301 Assessment of microbial colonization and kinetics degradation of *Distichlis* grass irrigated with fresh or brackish water in dromedary camels. G. Alhadrami*¹, A. El Awad¹, and M. Pessaraki², ¹*Department of Aridland Agriculture, College of Food Systems, United Arab Emirates University, Al-Muhandeseen - Giza,* ²*Department of Plant Sciences, University of Arizona, Tucson.*

An in situ study was conducted to investigate the extent and kinetics degradation of DM, NDF, ADF and microbial colonization of *Distichlis spicata* grass (halophytic grass) irrigated with fresh water (DFW)

or with brackish water (DBW) in the rumen environment of dromedary camels. Three camels fitted with rumen cannulas were used in this experiment. Camels were fed concentrate and Rhodes grass hay individually to maintain body weight constant and had free access to fresh water. *Distichlis* plants were labeled with ¹⁵N as an internal marker. Amount of ¹⁵N in excess of 0.366 atom% were considered as enrichment. Dilution of enrichment estimated percentage of microbial nitrogen. Labeled DFW and DBW grasses were weighed and placed in nylon bags and incubated in the rumen of the camels for up to 48 h. Differences in DM, NDF and ADF degradation were not significant between DFW and DBW, except at 48 hours the DM ($P \leq 0.04$) and NDF ($P \leq 0.027$) of DBW were significantly higher. Contamination expressed as percentage of microbial-N to total residual-N increased with incubation time and was less in DBW compared to DFW, differences were significant after 24 h ($P \leq 0.011$) and 48 h ($P \leq 0.001$) of incubation. Microbial colonization (expressed as percentage of microbial crude protein) and microbial cell mass followed the same trend. After 48 h of rumen incubation, microbial nitrogen was 30.3% in DBW and 42.6% in DFW. Microbial crude protein was 4.7% in DBW and 6.2% in DFW. In both DFW and DBW, microbial colonization and microbial contamination increased with incubation time. Microbial contamination affected estimates of in situ ruminal protein degradation of *Distichlis* grass irrigated with fresh water more than the *Distichlis* grass irrigated with brackish water.

Key Words: *Distichlis* Grass, Microbial Contamination, Dromedary Camels

W302 Effect of molasses on nutritional quality of *Pithecellobium dulce* silage. T. Clavero* and R. Razz, *La Universidad del Zulia, Venezuela.*

This study determined the influence of varying levels of molasses and ensiling time on the content of the nitrogenous fractions, chemical composition and fermentation quality during ensiling of *Pithecellobium dulce* in the farming systems of Venezuela. Chopped fresh plant materials of about 1 cm length were ensiled into laboratory silos 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, 1:8, 1:10, 1:12 (w/v) and three storage periods 1, 2 and 3 months. After opening the silos, dry matter (DM), pH, total nitrogen content (NT), rumen soluble nitrogen (SN), protein nitrogen (NP), nitrogen in acid detergent fiber (NADF), nitrogen fixed to the cell wall of the total nitrogen (NNDF/NT), in vitro DM digestibility (IVDMD), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined. DM of *Pithecellobium dulce* was not changed during ensiling and the molasses additive had not significant effect on the silage DM. The mean pH values decreased significantly ($P \leq 0.05$) with increased level of molasses and storage period, respectively. The lowest pH value (4.06) was obtained with the relation 1:12. No significant differences in NT, NP, NADF, NNDF/NT, pH, ADF and NDF were found between molasses treatments. Content of NS and digestibility increased significantly ($P \leq 0.05$) with increased level of molasses. Except for NP and NS, the ensiling time significantly affected ($P \leq 0.01$) the loss in digestibility, NT, NADF, NNDF/NT, pH, ADF and NDF. The greatest losses occurred within 1-2 months of ensiling. The results showed that *Pithecellobium dulce* fodder can be preserved successfully by ensiling with molasses additive.

Key Words: *Pithecellobium dulce*, Silage Quality, Molasses

W303 Cow preference between conventional sand bedded free stalls and free stalls with sand savers. R. J. Norell*¹, P. C. Deaton¹, J. H. Packham², and S. C. Parkinson³,

¹University of Idaho, Idaho Falls, ²University of Idaho, Paris, ³University of Idaho, Preston.

Sand is considered the gold standard bedding for free stalls but it can be expensive due to high sand utilization rates. Commercial sand saving devices have been developed to reduce sand utilization in free stalls. The objective of this study was to compare cow preference between conventional sand based free stalls and free stalls with sand savers on a commercial dairy operation with Holstein cows. The free stall facility had three rows of stalls. Each row had ten conventional sand stalls, ten with Agri-web (Presto Products, Appleton, WI) and ten with Sand Traps (Albers Inc., Jerome, ID). Free-stalls were 2.29m long and 1.22m wide. The neck rail was mounted on top of large loop cantilever stall dividers (1.13m above stall base) and located 1.73m from the back of the curb. Sand savers were positioned on top of tamped gravel and were installed 5cm below the top of the curb. Stalls were then filled with sand. The stocking rate was one cow per stall. Cows were milked 3x daily and had access to an outdoor dirt lot for 3h daily. Cow behavior was monitored for six-24 h periods with a digital camera system that saved images every 20 minutes. Data were analyzed as a randomized

complete block design with replication. Sand saver stalls had more h of stall occupancy/day ($p < 0.005$), more h of cow resting time ($p < 0.003$), and a higher stall turnover rate ($p < 0.01$) than control stalls. Occupancy, resting time, and stall turnover rate were numerically higher for Sand traps over Agri-web based stalls but differences were not significant ($p > 0.10$). Standing in stall behavior did not differ between the three stall bed surfaces ($p > 0.32$). Comfort index (h lying in stall divided by h occupy stall) averaged 90% and did not differ ($p > 0.69$) between stall treatments. Bedding was a fine grain sand that tended to compact in the control stalls but not in the sand saver stalls. Sand utilization did not differ between treatments but sand saver stall were used more hours per day and had a higher turnover rate. Cows appear to prefer stalls with sand saver devices over conventional sand stalls.

Stall usage	Control	Sand Trap	Agri-web	SE
Occupancy	8.1	11.4	10.5	0.3
Resting	7.3	10.3	9.5	0.3
Comfort index %	89.5	90.4	90.3	0.7
Turnover rates (times/d)	6.2	8.2	7.6	0.3

Key Words: Free Stall, Preference, Sand Bedding

ABSTRACTS
Wednesday, July 28, 2004

SYMPOSIA AND ORAL SESSIONS

* Author Presenting Paper

Contemporary and Emerging Issues: Current and Future Prospects for Animal Nutrition Management for Environmental Impact Reduction

642 Natural Resources Conservation Service (NRCS) involvement in animal nutrition management. T. Christensen*, *USDA NRCS*.

The Natural Resources Conservation Service (NRCS) is the lead federal agency for assisting landowners and landusers with conservation on private lands. It is an agency of the U.S. Department of Agriculture (USDA) and falls within the Natural Resources and Environment Mission Area, along with the Forest Service. The Animal Husbandry and Clean Water Programs Division (AH&CWPD) serves to develop National policies and provide leadership and direction for agency activities related to water quality and quantity, animal husbandry, nutrient management, and air quality programs and issues. The Division collaborates and coordinates with other NRCS divisions on all assigned activities and also acts as the primary interface between NRCS and the Environmental Protection Agency (EPA).

One of the primary responsibilities of the AH&CWPD has been the development of policy and guidance leading to voluntary Comprehensive Nutrient Management Plan (CNMP) implementation on animal feeding operations (AFOs). Feed management is one of the six core elements of the CNMP, and is defined as the managing of the diet or nutrition of the animal in such a way that manure nutrients are decreased, without negatively affecting the performance of the animal or profitability of the operation. Reduction of manure nutrients has been identified as a key action that can mitigate the potential effects of the animal industries on the environment.

Over the last few years, NRCS has developed an action plan to advance feed management, hosted two visiting animal scientists on six-month sabbaticals to help develop and guide policy in this area, conducted a National Dialogue on Feed Management and the Environment, and assessed interest in feed management through a series of sessions with industry animal nutritionists. The 2003 development and adoption by the agency of a National conservation practice standard on feed management allows an NRCS State Conservationist to adopt this practice

as eligible for cost-share under the Environmental Quality Incentives Program.

Key Words: Feed Management, Cost Share, Environmental Policy

643 Industry assessment of feed management practice implementation through animal nutritionist focus groups. G. Carpenter*, *USDA-NRCS*.

The animal industries in the United States produce approximately 250 million dry tons of manure each year from confined operations. Interest exists in ways to decrease the impact of animal production on the environment. A great deal of science and technology exists that supports the practice of reducing manure nutrients by improved feed management. Beginning in 2001, the USDA, NRCS Animal Husbandry and Clean Water Programs Division (AHCWPD) began to coordinate activities in the area of feed management with other divisions within the agency and other agencies within the USDA. An agency Feed Management Action Plan was implemented in the late summer of 2001 to pursue feed management opportunities.

A National Dialogue on Feed Management and Manure Nutrient Reduction was held in June, 2002 in Washington, DC. One of the findings from the Dialogue pointed to the small number of animal nutritionists controlling the diets of animals within the industry. A series of focus group sessions was held for animal nutritionists from the four major animal industries to learn about the needs of the animal industries for adopting feed management as a practice.

All four animal industries indicated that they are currently using a number of feed management practices. Most animal nutritionists felt that adoption of new practices is influenced by economics rather than implicit concern for the environment. Information on new practices and technologies comes from many sources, but speed of adoption depends on economics, risk, and funding. Research needs change by animal sector. Nutritionists felt that a strategy for NRCS to encourage the implementation of feed management practices should include networking with industry, the identification of vehicles for providing information on feed

management to industry, becoming more involved with applied research, demonstration and technology transfer on feed management, and looking for ways to provide incentives, both monetary and non-monetary, for the adoption of feed management practices.

Key Words: Feed Management, Environment, Industry Nutritionists

644 Development of rapid methods for assessing nutrient bioavailability. S. C. Ricke*, V. I. Chalova, and W. K. Kim, *Texas A&M University*.

Accurate assessment of nutrient bioavailability is critical for achieving an optimal balance between sufficient and excess for major feed components such as protein sources. Optimizing feed protein sources for farm animal amino acid (AA) requirements is difficult to achieve given the variations in protein quality. Feeding excess protein to meet AA requirements contributes to excess nitrogen (N) environmental pollution. To avoid productivity losses from an improper AA balance, feeds can be supplemented with pure AA to reduce animal N excretion. This requires AA bioavailability assessment by animal bioassays prior to supplementation. However in addition to the time commitment and costs,

activism interests are beginning to restrict routine animal tests. Ideally the animal feed industry needs alternative rapid methods for quantifying AA availability during feed processing. Rapid assays would allow animal nutritionists to adjust AA addition after assessing basal diet AA bioavailability. *In vitro* microbial bioassays for AA and other nutrients have been examined as a rapid alternative for a number of years. Such assays have the advantages of biological similarity to animal responses while retaining the flexibility and reproducibility capabilities of a conventional chemical test. Although several microorganisms have been examined, *Escherichia coli* has become the assay organism of choice because it is well studied, has simple growth requirements, and genetic modification is relatively easy. Given the molecular techniques currently available *E. coli* can easily be genetically engineered to provide an array of rapid whole cell AA biosensors. General application of this technology opens the door for more precise formulation at the feed mill and avoidance of unnecessary supplementation that result in animal production generated environmental problems.

Key Words: Nutrient Availability, Environmental Excess, Whole Cell Biosensors

Bioethics

645 Culture, values and ethics of animal scientists. John Hodges*, *European Association of Animal Production*.

Culture is defined as the shared worldview of a sub-set of humanity: race, nation, or professional group. In practice Culture means The way we do things around here. Values are the objectives that matter most to a person or to a cultural group to which priority of interest is consistently given in decisions allocating time, energy, resources, wealth and education. Ethics defines the moral component of each decision reflecting self-interest and/or concern about the well-being of other individuals or groups in society. Thus, in any sub-set of humanity, including professional animal scientists, Culture, Values and Ethics are closely linked. The normative cultural assumptions and commonly-held values of animal scientists guide group and individual decisions on the research and application of scientific knowledge. Strong links between animal scientists and business interests mean that the culture and values of commerce also inform and steer decisions by animal scientists. The food chain is increasingly watched by society as a whole, by governments and by special interest groups to determine the extent to which our behaviour is ethical or serving only our special interest group. The changing culture and values of societies in Europe and North America and Developing Countries are examined and compared with those of animal scientists. It is proposed that more radical changes in the culture and values of animal scientists are needed to match the assumptions of all societies for their food supply.

Key Words: Culture, Values, Ethics

646 An Argument that Animal Quality of Life Must be Central to Any Moral Justification of Animal Agriculture. W. R. Stricklin*, *University of Maryland*.

Personal experience has led to my belief that the majority of professional animal scientists have not seriously considered how they would

construct a full moral justification for animal agriculture. And current graduate programs in animal science commonly do not specifically challenge students regarding the moral basis of animal agriculture - or the implications of the student's research to this question. It is common for animal scientists to generally defend animal agriculture from a basis inclusive of premises such as 1) there is hunger in the world today, 2) the world population is expected to double in the next 30-50 years meaning more food must be produced, 3) animals utilize food stuffs not suited to human consumption, etc. However, rarely do animal scientists contend that food animals do - or can - benefit from their existence as sentient beings, i.e., having lived and experienced a reasonable quality of life. Singer originally argued in *Animal Liberation* that it is acceptable to produce food from animals provided they experience a quality of life comparable to that of a wild counterpart, but he subsequently argued that this is not possible with today's modern production systems. There is considerable agreement among the survey data on public attitudes indicating no trend toward vegetarianism or desire to move in that direction. However, there is very strong evidence in these same data sets indicating that the public seeks assurance that animals experience a reasonable quality of life. A utilitarian, or costs and benefits, moral argument for animal agriculture is strongest, possibly only defensible, when the quality of animal life can be predominantly placed into the benefits category - not included as a cost as many persons contend today. Incorporating consideration of the quality of the life experienced by animals into animal science teaching and research activities is in the best long-term interests of animal agriculture. It is also the right thing to do which further promotes the interests of all parties involved.

Key Words: Bioethics, Animal Sentience, Animal Science

Breeding and Genetics

647 Evaluation of Dorset, Finnsheep, Romanov, Texel, and Montadale breeds of sheep: Reproduction of F₁ ewes in spring mating seasons. K. A. Leymaster*, E. Casas, and B. A. Freking, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

Objectives were to estimate effects of sire breed (Dorset, Finnsheep, Romanov, Texel, and Montadale), dam breed (Composite III and north-western whiteface), mating season (March and May), ewe age (4, 5, and 6 yr) and their interactions on reproductive traits of F₁ ewes. A total of 1,099 F₁ ewes produced 1,754 litters from 2,330 exposures to Suffolk rams during 42-d mating seasons. Litter size and weight at birth were recorded and litter size and weight at weaning and 20 wk of age were analyzed separately for dam- and nursery-reared lambs. Total produc-

tivity from 4 to 6 yr of age for each ewe entering the breeding flock was calculated as the sum of 20-wk weights for dam-reared lambs. Interactions of sire breed x mating season, ewe age x mating season, and ewe age x dam breed were often significant. Interaction of sire breed x dam breed on conception rate ($P < 0.01$) was due to change in rank as well as magnitude. Averaged over mating seasons, Romanov x Composite III ewes had the greatest conception rate (93%) and Montadale x Composite III the lowest (64%). Interactive effects of sire breed and mating season on conception rate ($P < 0.001$) were due to differences in magnitude, with Romanov-sired ewes being most consistent between seasons (92% in March and 89% in May). Sire breed affected litter size at all ages ($P < 0.001$), ranging from 1.40 lambs at birth for Texel to 2.09 for Romanov. Differences between dam breeds in total productivity of dam-reared lambs were not detected, whereas ewes exposed in March (78

kg) were more productive ($P < 0.01$) than May (68 kg). Means of sire breeds for total productivity were 47, 65, 70, 70, and 111 kg for Texel, Montadale, Dorset, Finnsheep, and Romanov, respectively ($P < 0.001$). Superior reproduction of Romanov-sired ewes was due to greater conception rate and prolificacy at each mating season and ewe age. Use of Romanov crossbred ewes would increase fertility during spring mating, an important constraint of the sheep industry.

Key Words: Breeds, Reproduction, Sheep

648 Linear versus threshold model analysis of trainability in a colony of German Shepherd dog guides. J. Cole*¹ and E. Leighton², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD,* ²*The Seeing Eye, Inc., Morristown, NJ.*

The objective of this study was to compare linear and threshold models for genetic evaluation of trainability in a colony of dog guides. Data consisted of trainability and pedigree information on 3305 German Shepherd dogs produced for use as potential guides by The Seeing Eye, Inc (TSE). Trainability is used to assess the ability of a dog to work as a guide, and is scored on a 9-point ordinal scale. Scores range from 1 (worst) to 9 (best) and are assigned by TSEs training staff. A linear model (LM) is currently used by TSE to produce estimated breeding values (EBVs) for use in a selection index. However, theory suggests that a threshold model is the more appropriate tool for this type of analysis. A threshold model (TM) was used to estimate variance components and EBVs which were compared to the LM results. MTDFREML was used to fit the LM and CBLUP90REML was used to fit the TM. The model used for both analyses included fixed contemporary group and random additive animal and residual error terms. Heritability of trainability was 0.14 ± 0.03 and 0.19 for LM and TM, respectively. The algorithm used in CBLUP90REML prevented estimation of SEs in the TM. The higher heritability under the TM is consistent with theory. Pearson's product-moment and Spearman's rank correlations of LM and TM EBVs were 99.2 and 99.3, respectively, indicating that the LM does a good job of predicting and ranking the TM EBVs correctly. Genetic trend was positive for both analyses, 0.24 and 0.20 units/generation for LM and TM, respectively. Of the 3305 animals in the dataset, 2130 spent at least one day in training and 1175 did not. The distribution of trainability scores differed between dogs that spent at least one day in training and those that did not ($P < 0.001$). Trainability EBVs were higher for trained versus untrained animals under both the LM ($P < 0.01$) and TM ($P < 0.01$). While a TM is preferred from a theoretical viewpoint, the current LM does a good job of predicting genetic merit. The TM is preferred for the estimation of variance components, and suggests that the LM has been underpredicting the true heritability of trainability.

Key Words: Genetic evaluation, Dog guides, Threshold model

649 Developing breeding objectives for Targhee sheep. R. C. Borg*¹, D. R. Notter¹, R. W. Kott², and L. A. Kuehn¹, ¹*Department of Animal and Poultry Sciences, Virginia Polytechnic Institute and State University, Blacksburg,* ²*Department of Animal and Range Sciences, Montana State University, Bozeman.*

Breeding objectives were developed for Targhee sheep at different levels of prolificacy and triplet survival. Economic weights (EW) were derived for estimated breeding values (BV) from National Sheep Improvement Program genetic evaluations for 120 d weaning weight (WW), maternal milk (MM), yearling weight (YW), fleece weight (FW), fiber diameter (FD), staple length (SL), and prolificacy (LC; lambs born/100 ewes lambing). A commercial flock was simulated, accounting for nonlinear relationships between performance and profit. Ewes were assumed mated to sires of specified BV and profit was derived from lifetime performance of lambs and replacement females from that lamb crop. Economic weights were determined as change in profit from use of sires with BV that were one additive standard deviation above the mean for each trait [1.98 kg for WW, 1.62 kg for MM, 2.90 kg for YW, 0.36 kg for FW, 0.98 microns for FD, 0.74 cm for SL, and 17.58 lambs/100 ewes for LC], while holding all other BV at breed average. Separate breeding objectives were derived for different costs of meeting increased nutrient needs (P = purchase hay, R = rent pasture, and S = scaling back flock size). Based on replicated simulations, relative EW did not vary with prolificacy or survival ($P > 0.15$) but were affected by feed costs ($P < 0.01$). Selection indexes were derived within and across simulated scenarios, and correlation (r) among indexes of > 0.90 indicated that an

index could be used across multiple scenarios. Indexes derived within feed cost scenarios (P , R , and S) were strongly intercorrelated ($r > 0.97$). Correlations among average indexes (0.97 for R and P ; 0.70 for R and S ; 0.85 for P and S) indicated that two indexes could be used depending on whether flock size was scaled back (S) or not (NS) ($r=0.78$). Indexes were $1.0 WW + 0.23 MM + 0.61 YW + 0.95 FW + 0.26 FD + 0.08 SL + 0.18 LC$ for S and $1.0 WW + 0.33 MM + 0.26 YW + 1.25 FW + 0.29 FD + 0.09 SL + 0.24 LC$ for NS . For a standardized selection differential of one, the expected change in mean index values was 12.55 and 7.40 per ewe per generation for S and NS , respectively.

Key Words: Sheep, Selection Index, Breeding Objective

650 Genetic and environmental factors affecting camel reproduction. S. Hermas*, *Faculty of Agriculture, Department of Animal Production, University of Al-fatah, Tripoli, Libya.*

This study was conducted to evaluate the effect of various factors on female reproductive performance measured by days from parturition to first breeding (DMFB), service period (SP), days open (DO), number of services per conception (NS), conception rate (CR), calving interval (CI), age at first service (AFS), age at successful service (AS), service period (HSP), conception rate (HCR), age at first calving (AFC), and gestation length (HGL). The data used were 380 reproduction records from daughters of 11 sires. Two models were used to analyze the data. Model 1 included as fixed effects month of calving, season, sex of calf, color, age, and service sire. Model 2 included month and year of first service, the rest of factors in model 1 excluding month of calving, and sire as a random effect. The results of analysis of variance indicated a significant effect ($P < 0.05$) of month of calving on DMFB, NS, and CR. Season had highly a significant effect ($P < 0.01$) on DMFB, CI, and significantly affected CR and GL. Age had a highly significant effect on NS and CR. Service sire had a significant effect only on GL. In camel heifers, month of first service had a significant effect on AFS, AS, AFC, HNS, and HGL ($P < 0.05$). Sire and service sire had a significant effect on AS, AFC, HNS, HCR, CI, and HGL. Heritability, genetic and phenotypic correlations were calculated by paternal half sib method. Heritability estimates were 0.38 ± 0.16 , 1.1 ± 0.18 , 0.40 ± 0.17 , 0.02 ± 0.14 , 0.44 ± 0.16 and 0.39 ± 0.17 for DMFB, SP, DO, NS, CR, and AFC respectively. The repeatability estimates were 0.01 ± 0.09 , 0.11 ± 0.08 , 0.15 ± 0.08 , 0.18 ± 0.09 , 0.17 ± 0.08 , and 0.017 ± 0.09 for DMFB, SP, DO, NS, CR, CI, respectively. The additive genetic variation was fairly high indicating possible improvement through selection. Repeatability estimates were low, indicating large temporary environmental effects. The genetic and phenotypic correlations were estimated between all traits. These estimates ranged from medium to very high positive and negative indicating pleiotropic action of genes and common environment between traits of camel reproduction.

Key Words: Genetics, Camel, Reproduction

651 Development of web-based cow-calf decision support software. B. W. Bringham*, D. J. Garrick, and R. M. Enns, *Colorado State University, Fort Collins.*

Sire selection is an important decision directly affecting ranch profitability. The need for decision-support software is increasing with the growing number of EPD available. The objective of this project was to develop web-based tools to evaluate production and economic outcomes from the use of alternative sires. A model simulates the age structure of a herd to predict performance, revenues and costs while accounting for non-genetic effects such as age of the dam. Users provide a minimum number of production inputs comprising herd size, pregnancy rate, replacement rate, mature cow size, calf survival, birth and weaning weights. These define an equilibrium age structure and provide realistic production outcomes for the base herd. Genetic variables that simultaneously influence model behavior are limited to those economically relevant traits that are closely aligned to available EPD. These include heifer pregnancy, calving ease, mature cow size, cow maintenance requirements, stayability, birth and weaning weights. These EPD are used to derive a new equilibrium age structure and corresponding performance levels following perturbation of the base situation. The total number of cows is then modified, accounting for any change in feed requirements, to provide annual feed consumption identical to the base herd. Outputs from the model allow a producer to compare current herd production and economic performances to those predicted if alternative sires had been used and the system allowed to re-equilibrate. Primary

differences in revenue come from changes to the number and weight of sale calves. Other contributions to variation in revenue are from values of cull cows, replacement costs and dystocia costs. Discounting procedures are not included. In contrast to other models, the software provides for sire selection by simulation rather than simply generat-

ing economic values for subsequent use. Accordingly, the model needs to directly incorporate heterosis effects from multibreed evaluation and corresponding EPD from sire summaries.

Key Words: Decision Support, Cow-Calf, Sire Selection

Goat Species: Products

652 Protein profile of goat milk in relation with udder health status and somatic cell counts. G. Pisoni¹, L. Basiricò², P. Moroni¹, U. Bernabucci^{*2}, and G. Savoini³, ¹Dipartimento di Patologia Animale, Igiene e Sanità Pubblica Veterinaria, Milano, Italy, ²Dipartimento di Produzioni Animali, Viterbo, Italy, ³Dipartimento di Scienze e Tecnologie Veterinarie per la Sicurezza Alimentare, Milano, Italy.

The prerequisite to produce hygienic milk and cheese is udder health and, therefore, intramammary infections are the most persistent and widely spread group of diseases of importance to milk hygiene in dairy goats. The effect of udder health on yield and quality of milk and, consequently, on cheese yield and quality has been established. Milk from mastitic udders exhibits greatly increased proteolytic activity. The activity of plasmin (PL), plasminogen (PG), and plasminogen activator (PA) and their correlation with goat milk quality parameters (casein, somatic cell counts (SCC), and udder health status) were investigated. Forty goats from two flocks were monitored and used to provide milk samples. Does were machine milked twice daily without teat post-dipping. 50 mL of milk was collected aseptically from each goat and kept at 4°C until bacteriological procedures. The SCC were determined for each milk sample by an automated fluorescent microscopic somatic cell counter. Activities of PL, PG, and PA in milk were determined with a colorimetric assay. 5 mL of each milk sample was centrifuged and skimmed milk was analyzed to determine protein profile by SDS-PAGE. Quantification of the electrophoretically separated proteins was done by densitometry. Milk samples were categorized on the basis of the presence or absence of pathogens (healthy or infected udder) and as low SCC (< 1,000 × 10⁶/mL), medium SCC (between 1,000 and 2,000 × 10⁶/mL), or high SCC (> 2,000 × 10⁶/mL). The health status of the udder modified only SCC and PA activity; both parameters were higher (P < 0.01) in infected udders. The increase in SCC was followed by increases (P < 0.001) in PL and PA activities and γ -1, γ -2 and proteose-peptone contents, and by decreases in PG activity and α -casein and β -casein contents. Results of the present study demonstrate that udder health is not the main factor responsible for the increase of proteolytic activity and alteration of protein profile of goat milk.

Key Words: Goat, Milk, Protein Fractions

653 Silymarin administration to periparturient dairy goats: effects on milk production and quality. D. Tedesco^{*1}, S. Galletti¹, S. Rossetti¹, J. Turini¹, and G. Varisco², ¹Department of Veterinary Sciences and Technologies for Food Safety, Milan, Italy, ²Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna, Brescia, Italy.

Silymarin, a standardized extract from seeds of *Silybum marianum* L. (Gaertn) (milk thistle), is used for the treatment of liver diseases. Silymarin administration to periparturient dairy cows resulted in a lower postpartum body condition score (BCS) loss and a higher and earlier milk peak. The aim of the present study was to determine the effects of silymarin treatment in the periparturient period on lactation performance of dairy goats. A total of 24 dairy goats in their second pregnancy were divided into two groups according to BCS, health condition, and previous milk production. From 5 days prior to the expected kidding date to 15 d postpartum, the treated goats received 10 mL/d of silymarin as a water suspension, administered as an oral drench. Individual milk production was recorded on 7, 14, 21, and 28 DIM. Milk samples were collected on the same days and analyzed for protein, fat, lactose, urea, and somatic cell count. The BCS was evaluated on d -7, 0, 14, 21, and 28 from kidding. Silymarin treatment significantly increased milk production. In all days considered, milk yield of treated animals was higher with respect to control animals (P < 0.05). These differences were on average from 0.61 to 0.92 kg/d for each animal. Milk quality parameters were not different between treated and untreated goats. BCS was not different between groups. We conclude that silymarin administration to periparturient dairy goats had a positive effect

on milk production without affecting milk quality, confirming our results obtained with dairy cows. Silymarin was kindly granted by Indena S.p.A.

Key Words: Silymarin, Dairy Goat, Peripartum

654 Effects of goat breed and stage of lactation on yield, sensory quality, and fatty acid concentration of soft cheese. S. S. Zeng^{*}, K. A. Soryal, B. A. Fekadu, K. Tesfai, and B. Bah, Langston University E (Kika) de la Garza American Institute for Goat Research, Langston University, Langston, OK.

In the United States, Nubian and Alpine goats are two major dairy breeds and most dairy goat herds have a seasonal lactation. In this study, the effects of goat milk obtained from two dairy farms with different breeds of goats at various stages of lactation on yield, composition, sensory scores, and fatty acids of soft cheese (Chevré) were evaluated. Results obtained from this study indicated that dairy goat breeds did not affect cheese composition, sensory scores, or fatty acid concentrations (P > 0.05) except oleic acid. However, milk from Nubian goats resulted in a much higher cheese yield (2.71 vs 1.69 kg/10 kg of milk), a lower oleic acid concentration, and a lower unsaturated fatty acid concentration than that from Alpine goats (P < 0.05). Soft cheese made from late lactation milk had higher fat, protein, and total solids concentrations and yields than mid-lactation milk (P < 0.05). While the sensory scores of Alpine goat milk cheese varied throughout lactation, those of Nubian goat milk cheese were virtually the same regardless of stage of lactation. In conclusion, if a dairy goat herd is raised to supply milk for cheesemaking, Nubian goats or a mixed herd with at least some Nubian goats will be advantageous to cheese makers for a higher premium for their higher cheese-yield milk. In addition, a year-round breeding program could help minimize variations in cheese composition, yield, and fatty acid concentration, resulting in a more consistent quality of cheese throughout lactation.

Key Words: Goat Milk, Cheese, Fatty Acids

655 Growth and carcass characteristics of castrated or intact male Boer X Spanish goats grazing Marshall annual ryegrass. C. Hopkins-Shoemaker^{*1}, S. Solaiman², C. Kerth¹, W. Jones¹, and D. Bransby¹, ¹Auburn University, Auburn, AL, ²Tuskegee University, Tuskegee, AL.

Castration of food animals is a common management practice that imposes unnecessary pain and stress, is an extra cost, and may reduce performance. This study was conducted to determine the effect of castration on growth and carcass characteristics of Boer x Spanish goat kids. Seven intact males and seven wether goats (BW 38.03 and 34.79 ± 0.35 kg, respectively) were continuously grazed on Marshall annual ryegrass (*Lolium multiflorum* Lam.) for 56 d. Body weights were recorded after 4 h withdrawals from feed and water, for two consecutive days, every 2 wk. After d 56 animals were harvested and hot carcass weight (HCW), cold carcass weight (CCW), dressing percent (DP), kidney and pelvic fat (KPF), longissimus muscle area (LMA), backfat (BF), and other carcass parameters were measured. Average daily gain over 56 d was greater (P < 0.05) for intact males than for wethers (139 and 66 g/d, respectively). Carcass selection grades were similar between treatment groups: no differences (P > 0.10) were observed in HCW, CCW, or DP between treatment groups. Wethers had higher (P < 0.05) KPF than intact males (0.51 and 0.23 kg, respectively); however, BF and LMA did not differ (P > 0.10) between treatment groups. These results indicate that castration of young market goats reduced growth and did not provide any distinct advantage in carcass characteristics.

Key Words: Goat, Castration, Carcass Characteristics

656 Influence of maternal breed on meat goat carcass characteristics. R. Browning, Jr.*¹, C. Chisley², O. Phelps², S. H. Kebe¹, B. Donnelly¹, M. Byars¹, and T. Payton¹, ¹Tennessee State University, Nashville, ²USDA-Agricultural Marketing Service, Baton Rouge, LA.

Spanish x Boer (n = 16) and Spanish x Kiko (n = 18) wethers (7 mo) and bucklings (5 mo) were harvested under USDA inspection to evaluate the effect of dam breed on carcass traits of crossbred kids. Boer and Kiko dams, respectively, originated from five and seven seedstock farms. Each dam was purebred or fullblood (93.75 to 100%). Traits of interest included live weight and conformation score, carcass grade, carcass weight, dressing percentage, wholesale cut weights, and edible meat yield. Live weight tended to differ (P = 0.08) between Boer (22.96 ± 0.94 kg) and Kiko kids (25.6 ± 1 kg). Hot carcass weight, cold carcass weight, and dressing percentage tended to be greater (P ≤ 0.1) for Kiko than for Boer F1 kids. Kids out of Boer dams had similar (P = 0.29) live conformation scores as their contemporaries out of Kiko dams. Carcass grade scores for Kiko F1 tended to be better (P = 0.08) than those for Boer F1 kids. Paired shoulder and hind leg primal cuts were heavier (P < 0.05) for Kiko (1.66 ± 0.08 kg; 3.05 ± 0.14 kg) compared to Boer (1.41 ± 0.08 kg; 2.59 ± 0.13 kg). Paired foreleg and loin weights for Kiko (2.11 ± 0.1 kg; 1.5 ± 0.09 kg) tended to be heavier (P ≤ 0.10) than for Boer (1.85 ± 0.1 kg; 1.28 ± 0.09 kg). Rib weights were not different (P > 0.2) between breeds of dam. However, when wholesale cut weights were adjusted for carcass weight, only the hind leg tended to be heavier (P = 0.06) for Kiko-cross kids than for Boer-cross kids. Proportional edible meat yields and meat to bone ratios from shoulder, loin, and hind leg were not affected (P > 0.15) by breed of dam. Preliminary results suggest that breed of dam may affect carcass traits from commonly sired crossbred kids.

Key Words: Meat Goat, Breeds, Carcass Traits

657 Size, color, and texture of major muscles from kid goat carcasses. K. W. McMillin* and A. P. Brock, *Department of Animal Sciences, Louisiana State University Agricultural Center, Baton Rouge, LA.*

Production of value-added products for ethnic and non-traditional goat meat consumers requires information about the constituent raw materials. Linear dimensions and color of major raw muscles from Boer-Spanish kid goat carcasses and texture after moist and dry cookery were determined in two successive years (n=18 and n=10). After weaning and pasture rearing with 0.11 kg/d of corn, kid goats of average 9 mo age and 25 kg were humanely sacrificed. Carcasses were chilled for 24 h at 4°C before evaluation of carcass conformation (selection 2.6), flank color (A⁷⁰), external fat score (1.0), and kidney, heart, and pelvic fat (1.8%). Dressing percentage averaged 41% and cold carcass weight 10 kg. Individual muscles were manually separated by knife from fat and bone within a 3 d period. Weight, length, and width (ruler), diameter (caliper), and color (reflectance spectroscopy) were recorded for *L. dorsi* (LD), *Semimembranosus* (SM), *Q. femoris* (QF), *B. femoris* (BF), *Triceps* (T), *G. medius* (GM), *Infraspinatus* (I), *Supraspinatus* (S), *Psoas major* (PM), *Semitendinosus* (ST), and *B. brachii* (BB) at the time of separation. Muscles from each carcass side were randomly assigned to moist (water bath at 100°C) or dry (167°C oven) heating to 77°C internal temperature. Muscle weights were LD=SM>QF>BF=T#8805GM>I=S=PM=ST>BB. The differences (P<0.05) in length and diameter between muscles were more variable than the differences in L*, a*, and b* color values between different muscles. Cooking losses were less (P<0.05) for larger than smaller muscles, with shear force greatest (P<0.05) for S and least (P<0.05) for ST, BB, PM, GM, QF, T, LD, and I. Cooking losses (24 to 36%) and shear forces (3.0 to 4.7 kg) for each muscle type did not differ (P>0.05) with type of heating. Time to reach internal temperature was longer with dry than moist heating. Year did not influence linear, color, or shear measurements in muscles of the same type. Characterization of different muscles will assist in identification of muscles suitable for retail goat cuts and for processing into value-added products.

Key Words: Goat, Muscle Profile, Color

ADSA - Growth and Development

658 Effects of intramammary endotoxin treatment on porcine milk composition, yield, and resultant piglet growth performance. A. C. W. Kauf*, D. C. Pighetti, A. L. Magliaro, D. A. Pape, L. C. Griel, Jr., and R. S. Kensing, *Penn State University, University Park.*

Mastitis is a contributing factor to preweaning mortality in pork production. We performed an experiment utilizing an intramammary endotoxin (ET) challenge model (Kensing et al., 1999), to determine the effects of mastitis on milk composition, yield, and resultant piglet growth performance. Following cross-fostering to equalize litter size on approximately d 3 of lactation, 11 parity-one Yorkshire sows were challenged (1.5 µg/gland/kg BW) on days 13 and 20. ET (from *E. coli* O55:B5) was infused into two functional, previously non-infused mammary glands on each experimental day. Milk was collected by manual expression from both control and ET-infused glands before and after ET-challenge up to 60 h post infusion, and analyzed for protein content and composition. Milk yield was estimated by weigh-suckle-weigh procedure, and daily piglet weights were recorded. ET-infusion increased rectal temperatures, which peaked at 1.7 °C above baseline at 5 h (P < 0.01), returning to normal by 24 h. ET-infusion increased milk log TNF-α 87 %, chloride 221 %, total protein 20 %, and albumin 44 %; and decreased β-casein 47 % relative to control samples (P < 0.01). Apparent proteolytic degradation of α_s-caseins in post-infusion milk samples was dramatic. ET-infusion decreased hourly milk yields 31 % on experimental days (P < 0.01). ET-infusion decreased 24 h weight gains 75 % for piglets nursing ET-infused glands relative to their control littermates during the first 24 h; the difference in 24 h weight gain between groups remained significant through 5 days (P < 0.01). Our data demonstrate significant increases in milk TNF-α, chloride, total protein, and albumin; significant decreases in milk β-casein and yield; and prolonged decreased daily weight gains of suckling piglets. The changes in milk composition are consistent with opening of tight junctions, and the ET-

challenge model is valuable for studying the effects of mastitis in the sow.

Key Words: Porcine Mastitis, Milk Yield, Piglet Growth

659 Effects of diet and bST on gene expression profile of heifer mammary parenchyma. B. J. Lew*^{1,2}, S. S. Sipkovsky¹, G. J. M. Rosa¹, J. S. Liesman¹, R. P. Radcliff¹, H. A. Tucker¹, M. D. S. Oliveira², and M. J. VandeHaar¹, ¹Michigan State University, East Lansing, ²UNESP Jaboticabal, São Paulo, Brazil.

Increasing growth rates in prepubertal heifers decreases age at puberty and subsequent milk production. Administration of bST before puberty increases parenchymal tissue and decreases adipose tissue within the udder. Our objective was to examine the effects of a high energy, high protein diet combined with injection of bST on gene expression profile within mammary tissue and identify key genes that mediate mammary development. The mammary tissue used was collected in a previous experiment conducted in 1994 (Radcliff et al., 1997). In the experiment 38, Holstein heifers were randomly assigned to one of four treatments: low or high diet, each with or without bST. RNA from parenchymal tissue of 32 heifers (8/treatment) was extracted, and RNA quality was checked using the Agilent Bioanalyzer. RNA was pooled (2 samples/pool), and the 16-pooled samples were examined using a bovine-specific cDNA microarray (National Bovine Functional Genomics Consortium Library, NBFGC) containing 18,263 uniquely expressed sequence tags (EST). A Loop design was used with cDNA from the 16-pooled samples labeled with Cy3 or Cy5 dyes prior to microarray hybridization. Gene expression data were normalized for dye intensity biases using a robust local regression technique (SAS PROC LOESS). Significance levels of differential gene expression among treatments were assessed using a mixed model approach. Compared with no bST, bST altered expression of 671 genes (368 down and 303 up-regulated) in the high diet (P<0.05) and 365 genes (210 down and 155 up-regulated) in low diet (p<0.05).

When compared with low diet, high diet without bST¹ affected expression of 445 genes (168 down and 277 up-regulated) ($p < 0.05$). Genes altered included several hormones, growth factors, receptors and signaling pathway genes involved in mammatogenesis. Ongoing studies focus on verifying changes with Real Time PCR to measure gene expression profile within mammary gland. In conclusion, dietary energy and bST administration alter expression of genes involved in mammatogenesis *First author sponsored by CAPES (Coordination for the Improvement of Higher Education Personnel, Brazil) from may, 2003-april, 2004

Key Words: Mammary Gland Development, Nutrition, Microarray

660 Growth and developmental characteristics of Holstein and Gir (*Bos indicus*) x Holstein bulls and heifers.. S. Schmidt*¹, S. Bowers¹, T. Dickerson¹, K. Graves¹, R. Vann², and S. Willard¹, ¹Mississippi State University, Mississippi State, ²Brown Loam Experiment Station-Mississippi State University, Raymond.

The crossbreeding of Holstein cows with Gir sires has not been evaluated extensively in the southern United States. Gir cattle have a higher milk production potential than many other *Bos indicus* breeds, yet little information exists regarding the growth, development and production performance of Gir x Holstein crossbred dairy cattle. In this study, Holstein cows were bred by artificial insemination (AI) to either Holstein or Gir-sires, which produced Holstein x Holstein (H x H) or Gir x Holstein (G x H) calves. The objective of this study was to compare the growth and morphological differences of H x H and G x H crossbred dairy calves during their first year of life. Body weight, heart girth, hip width, hip height and wither height measurements were obtained from birth to 378 days of age at 28-day intervals. Calves were housed in hutches from birth until 55 to 60 days of age, and thereafter grazed on improved pastures. All growth and development traits were positively correlated with one another ($R=0.72$ to 0.99 ; $P < 0.0001$). A breed x sex interaction ($P < 0.05$) was noted in BW change and average daily gain (ADG). Specifically, G x H bulls ($n=8$; 0.78 kg/d) exhibited a greater ($P < 0.05$) ADG than H x H bulls ($n=12$; 0.73 kg/d), whereas H x H heifers ($n=18$; 0.80 kg/d) exhibited greater a ($P < 0.05$) ADG than G x H heifers ($n=22$; 0.74 kg/d). Wither height (124.9 ± 0.73 cm), hip height (128.9 ± 0.68 cm) and hip width (42.1 ± 0.32 cm) did not differ ($P > 0.10$) relative to sex of calf or breed. Heart girth was greater ($P < 0.05$) in bulls (164.0 ± 1.1 cm) than heifers (157.7 ± 1.2 cm), but was not influenced by breed ($P > 0.10$). In summary, while expected differences were observed between bulls and heifers in some growth characteristics, contrasting differences between G x H and H x H calves were noted only in ADG. Nevertheless, these data indicate that the growth and morphological development of G x H and H x H calves during their first year of life are relatively similar.

Key Words: Gir, Growth, Development

661 Growth of crossbred and purebred calves from birth to an age of 50 days studied by dual energy x-ray absorptiometry (DXA). J. Hampe, S. Nueske, A. M. Scholz*, and M. Foerster, *Experimental Farm, University Munich, Germany.*

Lean tissue (LTGR), fat tissue (FTGR) and bone mineral growth (BMGR) of female ($n=44$) and male ($n=40$) calves was compared among six different breeding types including German Holsteins (GH, $n=14$), German Fleckvieh (FV, $n=17$), GH sire x FV cow, ($n=16$), FV x GH, ($n=20$), GH x GHxFV crossbred (CR, $n=10$), and FV x CR ($n=7$) from day 4 until day 50 of life. Calves underwent three DXA scans under light sedation using a GE LUNAR DPX-IQ scanner with a three week interval. Up to day 15, all calves were fed individually cow milk (47 l) and housed outside in single calf boxes on straw. From day 16, calves were housed in groups on straw in a cold stall. They received age-dependent milk replacer over an automatic feeder (intake: $5.5 - 7.5$ l/d).

In addition, they received ad libitum hay, corn, and on-farm produced concentrate (average intake < 130 g/d). Generally, growth differences among calves originating from GH or FV sires and GH, FV or crossbred cows were small. During the age period 526 days, calves did not gain fat tissue. Alone calves of FV mothers showed in tendency a positive fat deposition, while calves of GH sires starting with a significantly lower body weight (BW) gained significantly more lean tissue than calves with FV sire. No significant differences in tissue growth could be observed during the second period (27-48 days). However, calves of FV sires gained in tendency more lean and fat than calves of GH sires resulting in still heavier calves at day 48. The breed of the sire seems to have a larger effect on early growth of calves than does the mothers breeding line.

	Start BW (kg)	FTGR ¹ (g/d)	LTGR ¹ (g/d)	BMGR ¹ (g/d)	FTGR ² (g/d)	LTGR ² (g/d)	BMGR ² (g/d)	Final BW (kg)
Sire Line								
GH	44±1 ^a	-10±9	365±31 ^a	13±1	16±10	358±44	9±1	59±2 ^a
FV	48±1 ^b	-17±10	282±34 ^b	11±1	23±10	424±48	10±1	64±2 ^b
Mother Line								
GH	46±1	-23±10 ^a	312±33	13±1	35±10	390±46	11±1	61±2
FV	45±1	4±9 ^b	316±32	11±1	15±10	407±45	10±1	62±2
CR	46±2	-21±14 ^{ab}	343±49	13±2	9±15	378±69	8±2	62±2

Significance ($p < .05$) among Least Squares Means is characterized by different superscripts. ¹ = age period: 5 - 26 days; ² = age period: 27 - 48 days

Key Words: Growth, Calves, Dual Energy X-Ray Absorptiometry

662 Portal nutrient flux during pre- and post-weaning growth in dairy calves. J. L. Klotz* and R. N. Heitmann, *Department of Animal Science, The University of Tennessee, Knoxville.*

Dairy calf weaning is associated with increases in ketone levels that exceed measured rates of utilization in adults and present a potential energy loss that may be mitigated by ionophore. To assess effects of weaning and ionophore on net portal-drained viscera (PDV) flux in dairy calves, glucose, acetoacetate (ACAC), BHBA, NEFA, VFA, insulin (INS), and glucagon (GLN) concentrations and PDV fluxes were determined on d 35, 56, 84, and 112 in Jersey bull calves weaned at d 49. From d 3-34 all calves ($n=14$) were fed 454 g/d milk replacer. After sampling on d 35, calves were randomly assigned to a commercial pelleted starter without (C) or with lasalocid (T; 83 mg/kg DM) *ad libitum* plus replacer until d 48. From d 49-112 calves received only C or T *ad libitum*. Calves were equipped with catheters in artery (A), portal (P), and mesenteric veins (V) at wk 3-4. Calf number varied by treatment and sample day due to catheter patency (calves = 3-5). Blood flow was measured by continual infusion of para-aminohippurate into V ($1.5\% @ 0.764$ mL/min) and 6 serial samples taken at 30-min intervals simultaneously from A and P. Portal blood flow increased ($P < 0.05$) with age, but did not differ between C and T. Glucose was released pre-weaning and extracted post-weaning by PDV, but not affected by ionophore. Pre-weaning uptake of NEFA changed to post-weaning release, but this change was delayed to d 84 in T. Flux of ACAC and BHBA in C and T went from pre-weaning uptake to post-weaning PDV release that peaked at d 84, but peak release of ACAC was lower and BHBA tended to be lower in T ($P=0.07, 0.15$). Portal release of VFA increased with age, but was similar to ketones with both butyrate and propionate release lower at d 84 in T ($P < 0.1$). Glucagon was greater in C than T at d 84 ($P < 0.05$). Significant changes in metabolic profile and net PDV flux of transition calves were demonstrated and ionophore appears to moderate alimentary output at a post-weaning period (d 84) where ketone concentrations have potential to exceed whole animal capacity for utilization.

Key Words: Weaning, Ionophore, Portal-Drained Viscera Flux

PSA - Environment and Management - Broiler Management

663 Impact assessment of feeding high-oil corn to poultry in Brazil. E. Kebreab*¹, J. France¹, R. Phipps², and S. Leeson¹, ¹Department of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada, ²School of AP&D, The University of Reading, Reading, UK.

Agriculture, especially intensive animal production, contributes significantly to environmental pollution. In poultry, only 30 - 40% of nitrogen

intake and 18 - 35% of phosphorus intake are converted to edible products. In major poultry exporting countries such as Brazil, reducing nutrient loss to the environment is paramount. The economic and environmental impacts of replacing traditional corn, the main ingredient in poultry rations, with a high-oil corn (HOC) variety were evaluated using specialist least cost ration formulation software based on linear programming principles. Parametric analysis showed that HOC based

rations cost up to \$14/tonne less than traditional corn based ones mainly because less ingredient is used to meet the birds requirements. This is equivalent to an annual savings of up to \$266 million to the Brazilian broiler and broiler-breeder producers. Diets formulated with HOC had a lower crude protein content than with traditional corn, and potentially could reduce annual nitrogen excreted to the environment by 5.3 Mtonnes. HOC provided a better nutrient profile than traditional corn, especially in essential amino acids such as methionine and lysine, which led to meeting amino acid requirements without having to increase the total crude protein content of the diet. The analysis also showed a potential to reduce phosphorus excretion by 842 tonnes/yr if HOC was to replace traditional corn, since the need to supplement rations with inorganic phosphorus sources such as dicalcium phosphate would be much lower. We estimate that 36.6 Mtonnes dicalcium phosphate can be saved annually using HOC in poultry rations in Brazil. The literature suggests replacing traditional corn with HOC does not affect bird metabolism and positive impacts on growth rate have been recorded. Substituting traditional corn with HOC has both economic and environmental benefits for the Brazilian poultry production without compromising efficiency of output.

Key Words: Poultry, High-Oil Corn, Environmental Pollution

664 Electrostatic space charge system for dust reduction and air quality improvement in commercial broiler facilities. C. Ritz*¹, B. Mitchell², B. Fairchild¹, M. Czarick¹, and J. Worley¹, ¹University of Georgia, ²Southeast Poultry Research Laboratory USDA-ARS.

Reducing airborne dust in enclosed animal housing has been shown to result in corresponding reductions in airborne bacteria, ammonia and odor. Technologies that have been shown to be effective for reducing airborne dust in animal areas include misting with an oil spray, water mists, extra ventilation, and electrostatic space charge systems. Increasing pressure from environmental groups to reduce PM-10 and ammonia emissions from animal housing has led to considerable interest by the poultry and swine industries for practical systems to reduce these air pollutants. An electrostatic space charge system (ESCS) was designed to reduce airborne dust and ammonia emissions from a commercial broiler production house. The ESCS for this application was based on patented technology that was developed to reduce airborne dust and pathogens and has proven effective in poultry hatcheries and broiler breeder pen trials. In the present study, dust and ammonia were measured at 10-minute intervals over a three-flock period in both a treatment and control house with built-up litter. Results of the study during the months of November through April indicate the ESCS reduced airborne dust by an average of 55%. Dust levels in the treatment house were consistently lower than in the control house. Ammonia levels in the treatment house averaged 8% lower than in the control house with most of the reduction occurring during the evening hours when ammonia levels were highest. No differences in bird activity were observed between treatment and control houses. Successful application of this technology in broiler houses has the potential for improving bird performance and reducing house emissions and caretaker health hazards.

Key Words: Electrostatic, Dust, Broiler

665 In-house composting of litter and poultry carcasses infected with avian influenza. G. W. Malone*¹, S. S. Cloud¹, R. L. Alphin¹, L. E. Carr², and N. L. Tablante², ¹University of Delaware, Newark, ²University of Maryland, College Park.

In February 2004 two Delaware farms were found to be positive for H7N2 avian influenza. The litter and carcasses were composted inside

the houses to minimize potential spread of the virus and to address environmental concerns. Farm A had two 12 by 122 m houses with 12,000 dual-purpose birds ranging from 3 to 26 weeks of age while Farm B had three similar size houses with 74,000 five week old commercial broilers. In each house the carcasses and litter were mixed to form a single windrow 97 m long. These windrows had a 10 cm litter base, 4 m wide, 1.5 m high, and capped with 8 cm of litter or sawdust to cover all carcasses. Windrows were turned inside the house, consolidated and capped with additional sawdust at 14 to 19 days. Although the litter moisture was not ideal for composting, temperatures in these windrows were sustained at 55 C for 10 consecutive days. All houses were heated to 38 C for three consecutive days after forming the windrows and again after turning the piles as an additional measure to inactivate this heat-sensitive virus. Virus isolation samples from the compost and house environment were taken prior to turning and again before compost removal from the house. The compost was removed from the house after one month, stockpiled on the farm, covered and allowed to age for another month. Educational materials were developed and used to train poultry company personnel on in-house composting procedures.

Key Words: Composting, Carcass Disposal, Avian Influenza

666 Spatial Variability of Nutrient Species Within a Poultry House. P. R. Owens*, D. M. Miles, and D. E. Rowe, *Waste Management and Forage Research Unit, USDA-ARS, Mississippi State, MS.*

Large broiler operations must annually collect and analyze litter for nutrient content under the U. S. Environmental Protection Agency's Concentrated Animal Feeding Operation Final Rule. The objective of this study was to determine the variability of nutrient species within a poultry house using geostatistical contour plots. This research was conducted in the summer on a tunnel ventilated poultry house that was 146 m by 12.8 m. Prior to sampling, the litter had twenty-eight flocks of chickens grown on it with decaking between each flock. The house was sampled on a grid at 5 m across the house and 12 m down the house for a total of 36 sampling points. The litter was sampled at day 1 and day 21 to examine litter properties. The pH was determined using 1:5 litter water ratio. The total N was determined by total Kjeldahl nitrogen method (TKN). The ammonium, nitrate and phosphate were extracted with DI water and analyzed using flow injection analysis. The litter samples were also dry ashed and total metals were determined using an ICP. For both sampling dates, the samples weren't random and the data did not follow a normal distribution, however, the data indicated a higher average concentration of TKN and ammonium in the cooling cell end of the house and decreased toward the fan exhaust end of the house. The average nitrate data also yielded higher concentrations at the cool cell end of the house and decreased toward the exhaust end of the house. The data from the geostatistical contour plots illustrated higher TKN and ammonium in the brood end of the house, which corresponded with the lower pH (8.6 vs. 7.5) also in the brood end of the house. The contour plots of the nitrate data illustrated highest concentration near the sidewall of the brood end of the house, which corresponded to the areas with the highest litter moisture. These trends held true with both day 1 and day 21. The water extractable P data did not indicate definite trends within the house during the day 1 and day 21 sampling times. These geostatistical estimates of the nutrient concentrations indicated an anisotropic distribution of the nutrients along the house and illustrated spatial variability of nutrient species within the poultry house.

Key Words: Broiler, Litter, Nutrients

PSA-Nutrition: Feed Additives

667 Egg antibody to phospholipase A₂ increases carcass yield in male broilers. K. D. Roberson*¹, J. L. Kalbfleisch¹, W. Pan¹, R. A. Charbeneau¹, M. E. Cook², and M. Yang², ¹Michigan State University, East Lansing, ²University of Wisconsin-Madison.

Cockerel chicks (Ross X Ross) were procured from a commercial hatchery and placed at day of age into brooding pens which had fresh litter top-dressed on used litter from a previous trial. Dried chicken egg (whole contents) antibody to phospholipase A₂ was added at 0, 0.1, 0.2

or 0.4% of a corn-soybean meal basal diet fed in three phases. Chicks were brooded for 2 wk with 223 chicks/pen and 4 pens/treatment. After brooding, the birds were separated out into 7 pens/treatment with 125 birds/pen and grown to 43 d of age. Body weight and feed consumption were measured for each pen at 14, 28 and 42 d of age. At 43 d of age, 25 birds/treatment (5 pens of 5/pen) were randomly selected for slaughter and weighed live (averaged 3 kg). Hot carcass weight without giblets was determined and small intestinal samples were collected, washed and weighed individually. There were no significant effects on body weight

or feed conversion. Carcass yield was increased ($p < 0.0001$) linearly as level of antibody increased (70.8 to 73.0%). Intestinal weight was increased ($p < 0.0063$) linearly as antibody level increased. The results show that feeding an antibody to phospholipase A₂, an enzyme that affects arachidonic acid metabolism, to male broilers can increase hot carcass yield by 3% (2.2 percentage units) when supplemented at 0.4% of the diet from whole egg contents.

Key Words: Broiler, Carcass Yield, Phospholipase A₂

668 Effect of growth promoters (antibiotics + Roxarsone + copper sulfate) on broiler performance during stress: Possible mechanisms of growth promotion. A. Mireles Jr.*¹, D. Sutton¹, E. Koutsos², R. Spiller², and S. Kim¹, ¹Foster Poultry Farms, ²California Polytechnic State University, San Luis Obispo.

The objective of this study was to examine the effects and interactions of growth promoters and litter quality on broiler performance during stress. A 2 (NoGrowth vs. +GrowthP) x 2 (Clean vs. Dirty Litter) factorial design study was conducted in commercial-like pens for 43 d. Birds raised on dirty litter had heavier ($P < 0.05$) weight at 20 d (649 vs 672) and 33 d (1648 vs 1684). +GrowthP birds had heavier ($P < 0.05$) weight at 20 d (672 vs 649). Feed/gain was poorer ($P < 0.05$) for birds on growth promoters at 11 d (1.13 vs 1.09). Mortality was similar for all groups (2.21, 2.78, 1.60, 3.19%, respectively). At 11, 17, 34, and 41 d, 12 birds per treatment were injected subcutaneously with 1 mg *E. coli* LPS/Kg BW, and their body temperature measured at 0 and 150 m post-LPS. Birds fed growth promoters developed a similar fever 150 m post-lps throughout all 4 periods (+0.41, +0.39, +0.45, +0.32 C respectively). NoGrowth birds had higher ($P < 0.05$) fever at 11 d and lower at 41 d (+0.64, 0.55, 0.46, 0.22 C, respectively). Gain 2 days post-LPS challenge was higher ($P < 0.05$) for GrowthP birds at 13 d (63 vs 55 gm) and lower ($P < 0.05$) at 19 d (636 vs 687 gm). Intestinal coliform counts at 13 d were lower ($P < 0.05$) in birds on dirty than clean litter (171,425 vs 6809). Bursal disease and *I. bronchitis* titers were increased ($P < 0.05$) by dirty litter. Growth promoters likely improve performance by modulation of the inflammatory response.

Key Words: Growth Promoters, Litter Quality, Acute Phase Response

669 Growth performance of male broiler chicks fed diets supplemented with two levels of Versazyme® to 26 days of Age. N. H. Odetallah*¹, M. H. Fosnaught¹, and J. C. H. Shih², ¹Bioresource International, Raleigh, NC, ²North Carolina State University, Raleigh.

Two inclusion levels of Versazyme (VZ), a feed additive enzyme, were supplemented in broiler diets to determine the optimal level for broiler growth performance from 0-26 d. Birds were fed a control basal diet without (C) or with VZ (0.05% or 0.10% wt/wt). Diets were formulated to NRC (1994) with the exception of CP (19%) and Amino Acids (110%) as research indicates VZ has protease activity and is optimized at lower CP levels. VZ was added in the dry form post mixing of original mash feed. A total of 168 Ross x Ross male broiler chicks were allocated to 24 pens of a battery brooder in a Completely Randomized Design with 12 replicate pens/control and 6 replicate pens/treatment (0.05 or 0.10%); the experimental unit was a pen of 7 birds. Body weight (BW), Gain, and Feed intake were determined at 14, 21, and 26 d, and mortality used to calculate adjusted feed conversion ratio (adjFCR). Level of VZ had no effect on mortality. Feeding VZ increased ($p < .01$) BW at 21 d (852b and 915^a vs. 807^c g for 0.05 and 0.10% vs. C, respectively) and 26 d (1143^b and 1213^a g vs. 1092^c g for 0.05 and 0.10% vs. C, respectively) and Gain at d 21 (412^b and 441^a g vs. 385^c g for 0.05%, and 0.10% vs. C, respectively). Feeding VZ increased ($p < .01$) overall Gain (1102^b, and 1173^a vs. 1052^c g/bird for 0.05% and 0.10% vs. C, respectively) and improved ($p < .01$) overall adjFCR (1.47^a and 1.44^a vs. 1.55^b for 0.05% and 0.10% vs. C, respectively). There was no effect of VZ level on Feed Intake except at d 14 when it was increased ($p = .02$) by the 0.10% inclusion level (520^b, 517^b, and 556^a g/bird for control, 0.05%, and 0.10%, respectively). Both levels of VZ improved growth performance of broilers up to d 26 although the 0.10% level demonstrated a higher response ($p < .01$) in BW and Gain over the 0.05% level. Results of the current research suggest that supplementing diets with VZ at either the 0.05% or 0.10% level will improve broiler growth performance up to 26 days of age but optimal performance will be realized at the 0.10% level.

Key Words: Versazyme®, Growth Performance, Broiler Chick

670 Effects of purified β -Mannanase and commercial product, Hemicell® on performance and uniformity in commercial broilers compared with dietary nutrient adjustment. M. E. Jackson*¹, H.-Y. Hsiao¹, D. M. Anderson¹, R. L. James¹, and G. F. Mathis², ¹ChemGen Corp., Gaithersburg, MD ²Southern Poultry Research, Inc., Athens, GA.

β -Mannans are antinutritional components of soybean meal and other plant protein sources. An enzyme product containing primarily β -mannanase with lower levels of other enzymes including α -galactosidase, xylanase, amylase, and β -glucanase (Hemicell®) has been demonstrated to break down soybean β -galactomannan and improve performance in broiler chickens. An experiment was conducted to determine 1. The extent to which the efficacy of the commercial product (Hemicell®) is due to the presence of β -mannanase, and 2. if the growth performance loss due to adjusting energy downwards by 120 Kcal/Kg ME and amino acids downwards according to matrix recommendations can be recovered by the use of the enzymes. Four dietary treatments consisting of 1. a positive control, 2. a negative control with nutrient reductions, 3. as (2) with the commercial product, and 4. as (2) with purified β -mannanase were provided to 8 replicate pens with 30 male CobbxCobb broilers per pen. All diets were corn-soybean meal based. Individual body weights of all birds were determined on days 17 and 42. Addition of the commercial product to the low nutrient dense diets resulted in live performance improvements comparable to that of increasing the nutrient density (5.6% in gain and 7.7 points in feed conversion, $P < 0.05$). Addition of the purified enzyme also yielded significant improvements in live performance over its negative control. There was no statistically significant difference in performance between commercial product and purified enzyme. Body weight uniformity was significantly improved with the commercial product with a 38% reduction in 42-day %CV ($P < 0.05$). The data shows that the active ingredient of the commercial enzyme product (Hemicell®) is primarily the β -mannanase component, and that β -mannanase is capable of improving performance comparable to an increase in nutrient density on the order of 120 kcal/kg ME plus an additional amino acid benefit.

Key Words: Broilers, β -Mannanase, Uniformity

671 Efficacy of purified β -mannanase isolated from Hemicell® in broiler chickens with Coccidiosis and Necrotic enteritis. H.-Y. Hsiao*¹, D. M. Anderson¹, M. E. Jackson¹, F. L. Jin¹, and G. F. Mathis², ¹ChemGen Corp., ²Southern Poultry Research, Inc.

Hemicell®, a β -mannanase based feed enzyme, has been shown to significantly improve growth performance, and reduce mortality and lesion scores in broiler chicks simultaneously challenged with *Eimeria* sp. and *Clostridium perfringens*. Since β -mannanase used in these trials is a commercial product with some side activities such as amylase, xylanase, β -glucanase and α -galactosidase, etc. an experiment was designed to determine if the benefits observed are due solely to β -mannanase. β -Mannanase was purified through ion exchange (DEAE-Sephacel) and hydrophobic interaction (Phenyl-Sepharose) chromatography to remove all other enzyme activities. The purified mannanase produced a single band on SDS acrylamide gel electrophoresis demonstrating a high level of purity. A 21-day male broiler chick (CobbxCobb) trial was conducted in battery cages with 10 birds per cage, 4 diets, and 8 replications per treatment. Birds were fed diets with four different treatments: Control without medication, Hemicell® added, pure β -Mannanase added and Medication (BMD and salinomycin) added. All birds were challenged with 50,000 *E. acervulina* and 5,000 *E. maxima* on day 7 and with 108 cfu *C. perfringens* on days 12, 13, and 14, all by oral gavage. Results indicated that pure β -mannanase significantly improved weight gain by 9.4% (700g vs. 640g; $P < 0.05$) and feed conversion by 5.4% (1.440 vs. 1.519; $P < 0.05$) over its Control. Hemicell® gave a similar performance improvement over the non-medicated control indicating that the β -mannanase is the primary active ingredient in Hemicell®. This result also provides a foundation for a better understanding of the mechanism of action for Hemicell®.

Key Words: Broilers, β -Mannanase, Necrotic Enteritis

672 Effect of Growth Promoters (Antibiotics + Roxarsone + Copper Sulfate) on Broiler Composition during Stress: Possible Mechanisms of Growth Promotion. A. Mireles Jr.*¹, D. Sutton¹, E. Koutsos², R. Spiller², and S. Kim¹, ¹Foster Poultry Farms, ²California Polytechnic State University, San Luis Obispo.

The objective of this study was to examine the effects and interactions of growth promoters and litter quality on body composition during stress. A 2 (Clean vs. Dirty Litter) X 2 (NoGrowth vs. +GrowthP) factorial design study was conducted in commercial-like pens for 43 d. At 11, 17, 34, and 41 d, 12 birds per treatment were injected subcutaneously with 1 mg E. coli LPS/Kg BW. Two days post-LPS, birds were euthanized. Litter x Growthp x Stress interactions were found ($P < 0.05$) for total serum Ca, liver, spleen, tibia, breast relative weight, and tibia Ca and total P. LPS stress increased ($P < 0.05$) total serum Ca at 19, 36, and 43 days (+11, +4, +4 PPM), liver weight at 13, 19, 36, and 43 d (+0.21, +0.62, +0.36, +0.25%), spleen weight (+0.03, +0.03, +0.01, +0.02%), decreased ($P < 0.05$) breast weight at 19 d (-0.37%) but increased breast moisture at 36 d (+0.77%), and decreased tibia strength at 13 and 43 d (-458, -2868 gm) while increasing ($P < 0.05$) tibia Ca (18.67 vs. 19.87%) and P (8.61 vs 9.13%). At 19, 36, and 43 d, +GrowthP birds had constant serum Ca levels 2 d post-LPS challenge. NoGrowth chicks had higher serum Ca 2 days post-LPS at 19, 36, and 43 d. Spleen weight of NoGrowth chicks was heavier 2 d post-LPS at 36 and 43 d (+0.01, +0.01%). Tibia Ca and P, breast weight and moisture of NoGrowth were higher ($P < 0.05$) than in +GrowthP chicks. Growth promoters likely affect body composition by modulation of the acute phase response.

Key Words: Growth Promoters, Litter Quality, Acute Phase Response

673 Effect of mannan oligosaccharides supplementation to laying hen diets. M. I. Gracia*¹, P. Cachaldora², L. Tucker³, F. Baucells¹, and P. Medel¹, ¹Imasde Agropecuaria, S.L., Spain, ²Coren, S.C.L., Spain, ³Alltech Inc., Ireland.

A study was conducted to determine the effect of feeding laying hens a diet supplemented or not with a source of mannan oligosaccharides (MOS, Bio-Mos[®]) on performance and egg quality. A total of 1,200 Isa Brown laying hens (38-66 wks of age) were allocated randomly to the experimental treatments. A completely randomized block design was applied using two barns (block) and two experimental treatments: 1) basal diet (control), 2) basal diet with 1 g/kg of MOS. Each treatment was replicated 40 times (20 per barn) with 15 laying hens constituting the experimental unit. Egg production, average egg weight, feed efficiency, Haugh units, yolk color measured by Roche Color Fan (RCF), and shell thickness were calculated every 4 wks. For the whole study period (38 to 66 wks of age), MOS supplementation significantly improved laying index (85.1 vs 86.9%; $P < 0.01$), feed consumption (114.3 vs 115.7 g/d; $P < 0.01$), and feed conversion (2.09 vs 2.06 g feed/g egg; $P < 0.05$). Moreover, average egg weight significantly increased from 54 to 58 wks (65.2 vs 66.1 g; $P < 0.05$) and tended to increase from 58 to 62 wks of age (65.8 vs 66.5; $P = 0.09$) with supplementation of laying hen diets with MOS, but the positive effect was lost thereafter. Addition of MOS had no effect on the ratio between normal, dirty and broken eggs. Regarding egg quality parameters, the addition of MOS to the diet of laying hens resulted in a deeper yolk color as measured by the RCF (12.5 vs 12.8; $P < 0.001$), however control hens had higher Haugh units than MOS supplemented hens ($P < 0.05$). It was concluded from this experiment that the addition of MOS to laying hen diets results in improved laying performance and deeper yolk color.

Key Words: Mannan Oligosaccharides, Laying Index, Laying Hens

674 CRINA[®] poultry essential oils and BMD in the diet of broilers exposed to Clostridium perfringens. M. Sims*¹, P. Williams², M. Frehner³, and R. Losa³, ¹Virginia Diversified Research, Harrisonburg, VA, ²Akzo Nobel Surface Chemistry LLC, Davis, CA, ³CRINA SA, Akzo Nobel Group, Switzerland.

Two 7 week floor pen trials were designed to determine if the performance of broiler chickens fed CRINA[®] Poultry Essential Oils was similar to that of broiler chickens fed the growth promotant Bacitracin MD in the presence of a *C. perfringens* (Cp) challenge. In Trial 1 there were 8 groups replicated 8 times: Non-supplemented Uninfected Controls (NUC), Non-supplemented Infected Controls (NIC), Uninfected CRINA 100 ppm (UCR100), Infected CRINA 100 ppm (ICR100), Uninfected

BMD 55 ppm (UBMD), Infected BMD 55 ppm (IBMD), Uninfected CRINA 200 ppm (UCR200) and Infected CRINA 200 ppm (ICR200) for a total of 64 pens (64 birds/pen; density = 0.073 m² /chick). In Trial 2 there were 3 groups replicated 10 times: NIC, ICR100 and IBMD for a total of 30 pens (60 birds/pen; density = 0.078 m² /chick). Broilers of both trials were weighed at 7 weeks of age, challenged with Cp during Week 3 and Cp lesions scored at 7 and 28 days post-challenge in Trial 1 and 7 and 14 days post-challenge in Trial 2. In Trial 1, there were no differences ($p \# 88050.05$) between the Week 7 average live weights of the NIC, ICR100, ICR200 and IBMD fed broilers while in Trial 2 the ICR100 broilers had heavier Week 7 live weights ($p \# 88040.05$) than both the IBMD and NIC groups (2.39 vs. 2.27 and 2.21 kg, respectively). Both IBMD groups had heavier ($p \# 88040.05$) live weights than their NIC counterparts. Week 7 feed conversions and mortality rates of the ICR100 and IBMD groups in both trials were not different ($p \# 88050.05$). There were no differences ($p \# 88050.05$) between the Week 4 Cp lesion scores of the ICR100 and IBMD groups in each trial and both were significantly better ($p \# 88040.05$) than their respective NIC groups. ICR200 broilers performed slightly better than ICR100 broilers (Trial 1). This study suggests that challenged and non-challenged broilers fed diets supplemented with CRINA at 100 ppm had live weights, feed conversion and mortality rates that were similar or better than identically managed broilers fed BMD 55 ppm with both groups better than the Cp infected untreated controls.

Key Words: Essential Oils, Broiler, *Clostridium perfringens*

675 Comparison of direct-fed microbial products Avi-Lution or Avi-Lution Custom to bacitracin methylene disalicylate or no additive in diets of broiler chickens exposed to Clostridium perfringens. D. Spangler¹, J. Corley², G. F. Mathis³, M. D. Sims⁴, and D. M. Hooze*⁵, ¹Agri-King, Inc., Fulton, IL, ²Prince Agri Products, Inc., Quincy, IL, ³Southern Poultry Research, Inc., Athens, GA, ⁴Virginia Scientific Research, Inc., Harrisonburg, ⁵Hooze Consulting Service, Inc., Eagle Mountain, UT.

The objective was to evaluate direct-fed microbials versus an antibiotic or no supplement. In 49-d Exp. 1, Ross x Hubbard HiY mixed-sex chicks (2,700), 54/pen (1.22 x 3.05 m; 10 pens/treatment), were on fresh litter then on built-up litter (d 14). Four birds were removed at 21 d (2) and 35 d (2) for necrotic enteritis lesion scoring. The 5 treatment groups had different dietary supplements and *Clostridium perfringens* (Cp) challenge statuses: no-Cp negative control (nCON), Cp inoculated nCON (nCON+Cp), bacitracin-md 55 ppm (BMD+Cp), Avi-Lution 0.05% (AVN+Cp), and Avi-Lution Custom 0.1% (AVC+Cp) treatments. Birds were individually dosed with fresh culture of Cp types A, C, and D (ATTC, Ames, IA) on d 14, 15, 16, and 17. Intestinal lesions were scored 0 best to 4 worst at 21 and 35 d. Body weight (BW), FCR, lesion scores, and mortality (MORT) were improved ($P < 0.05$) by AVN+Cp, AVC+Cp, and BMD+Cp compared to nCON+Cp. In 49-d Exp. 2, Cobb x Cobb male chicks (1,400) were placed 40/pen with 5 pens/treatment. Coccidial challenge at 14 d was followed by fresh culture of southeastern field isolate of Cp mixed with feed on d 18, 19, and 20. At 22 and 28 d, 5 birds/pen were lesion scored. The 7 dietary treatments were: nCON, nCON+Cp, AVN(0.05%)+Cp, AVN(0.1%)+Cp, and BMD(55 ppm)+Cp. At 49 d, BW and FCR for the nCON, AVC+Cp treatments, and BMD+Cp were statistically similar ($P < 0.05$). The MORT was variable (3.5 to 11.5%) and nonsignificant. The AVC+Cp increased BW 3.7% and decreased FCR 4.5% compared to original AVN+Cp. The 49-d pen drag swab Salmonella concentrations were decreased by AVN+Cp or AVC+Cp compared to nCON+Cp or BMD+Cp. The AVN and to a greater extent AVC resulted in lower Salmonella counts and BW, FCR, and Cp lesion scores similar to BMD for broilers.

Key Words: Avi-Lution, Broiler, *Clostridium perfringens*

676 Growth performance of male broiler chicks fed diets supplemented with Versazyme[®] in dry and liquid form to 26 days of age. N. H. Odetallah¹, M. H. Fosnaught*¹, and J. C. H. Shih², ¹BioResource International, Raleigh, NC, ²North Carolina State University, Raleigh.

Two application forms of Versazyme[®] (VZ), a feed additive enzyme, were evaluated in broiler diets to compare the effect of the dry (D) vs. liquid (L) form on broiler growth performance from 0-26 d. Broilers were fed a basal diet without (Control) or with VZ (D or L). Diets were

formulated to NRC (1994) with the exception of CP (19%) and Amino Acids (110%) as research indicates VZ has protease activity and is optimized at lower CP levels. Diets were fed in the mash form from 0-26 d, and VZ was either added post mixing of original feed (D) or sprayed on top of the feed (L). A total of 168 Ross x Ross male broiler chicks were allocated to 24 pens of a battery brooder in a Completely Randomized Design with 12 replicate pens/control and 6 replicate pens/treatment (D or L); the experimental unit was a pen of 7 birds. Body weight (BW), gain, and feed intake were determined at 14, 21, and 26 d, and mortality used to calculate adjusted feed conversion ratio (adjFCR). Feeding VZ (whether in D or L form) compared to the control diet did increase ($p < .01$) overall Gain (1012^b, 1108^a, and 1087^a g/bird for control, D, and L, respectively) and improve ($p < .01$) overall adjFCR (1.52^b, 1.47^a, and

1.42^a for control, D, and L, respectively). Supplementing VZ in the D form did increase overall ($p = .04$) feed intake (1543^b, 1630^a, and 1545^b for control, D, and L, respectively). FCR at d 14 only was most improved ($p < .01$) by the L form (1.24^a) followed by D form (1.29^b) when compared to control (1.34^c). No difference between the two applications (D vs. L) was observed on mortality, BW, and gain at any age. Supplementing diets with VZ improved all broiler growth parameters measured in this study. These results suggest that VZ supplementation in broiler feed may improve growth performance irrespective of application form (D or L).

Key Words: Versazyme[®], Growth Performance, Broiler Chicks

PSA-Nutrition: Layer and Miscellaneous Nutrition

677 The influence of restricted intake of energy and fat on egg solids in laying hens. J. A. Arthur^{*1}, K. S. Kreager¹, N. P. O'Sullivan¹, and H. J. Kuhl, Jr.², ¹Hy-Line International, Dallas Center, IA, ²Nest Egg Nutrition, Gardnerville, NV.

Restriction of feed or energy intake has been noted to have an association with a reduced proportion of solids in liquid egg. Hy-Line variety W-98 and W-36 hens were fed rations designed to restrict energy and fat intake by 10% (Low group) for each variety, compared to hens fed a measured amount of feed in accordance with expected intake level for that variety (High group). The amount of feed provided to the W-98 High, W-98 Low, W-36 High and W-36 Low groups was 104.3, 95.2, 95.2 and 86.2 g/bird/day. The energy intake was 297, 265, 276 and 243 kcal/bird/day. The intake of crude fat was 3.45, 3.15, 4.36 and 3.93 g/bird/day. All other critical nutrients were fed at approximately the same level to both High and Low groups within variety. After nine weeks (period one), the feed given to each group was reduced by a further 10% for eight weeks (period two). Eggs were sampled five times during a pre-trial period, 5 times during period one and 8 times during period two, at intervals of one week or more. Egg weight (EW), % yolk (PY), white solids, yolk solids (YS) and total liquid solids (TS) were determined. Body weight (BW) was measured biweekly. Feed consumption (FC) and % production (PD) were measured daily. Results during the experimental period were corrected for differences between groups within variety during the pre-trial period. During period one, not all the feed was consumed and the % restriction was somewhat less than planned. The effect of energy and fat restriction on solids was not significant in period one, but was in period two. In period two there was a significant reduction of 0.32% in TS in the Low group (P#88040.001). TS were reduced because of reduced YS and PY (P#88040.01 and 0.0004, respectively). PD was reduced by 13% (P#88040.0001). Comparison of varieties over both experimental periods showed significant differences for W-36 in contrast with W-98 of 0.81% higher TS, 0.75% lower YS, 2.93% higher PY, 3.89 grams lower EW, and 0.14 Kg. lower BW (P#88040.0001 for each trait).

Key Words: Egg Solids, Energy Restriction, Fat Restriction

678 Evaluation of prediction equations and modeling metabolizable energy intake for commercial strains of laying hens. M. A. Jalal^{*}, S. E. Scheideler¹, and D. Marx², ¹Department of Animal Science, ²Department of Statistics, University of Nebraska, Lincoln.

A study was conducted to assess and contrast the accuracy of 4 existing metabolizable energy intake (MEI) prediction equations (Combs, 1968; Emmans, 1974; NRC, 1981, and NRC, 1994) and our Jalal model using our production data to derive equations for individual strains. Three strains of White Leghorn hens (Hy-Line W-36, Hy-Line W98, and Bovans) were fed 2 levels of dietary ME in a 2 x 3 factorial arrangement in an augmented block design. A total of 60 hens were used for this trial with 10 replicate cages (hen/cage) per dietary treatment. Modified models were derived by reparametrizing parameter estimates of explanatory variables in originak models using nonlinear regression. Results of model assessment showed that Combs model had significantly (P#88040.05) greater bias and mean square error (MSE) values for all strains, and was least accurate predictor of MEI among models evaluated. Therefore, Combs was excluded from further evaluation. NRC models were the best predictors and had the least bias and MSE, with Emmans and Jalal in close second and third. Pooled data results showed modified models predicted MEI more accurately in contrast to original models

for Hy-W36, while only modified Emmans and Jalal were more accurate for Hy-W98 and Bovans. An F-test showed significant differences among strain-derived equations for all models. These equations were tested using 2 sets of field data per strain acquired from a commercial layer facility. Testing of strain-derived models using field data showed no significant differences in bias or MSE estimates for Emmans, NRC or Jalal models for accuracy of predicting MEI. The results indicated that the models fit the field data well for all strains. The NRC models were the best predictors of MEI for the present data set for all strains. Testing of the strain-derived equations using field data showed that Emmans, NRC and Jalal were accurate predictors of MEI as demonstrated by non-significant comparisons of bias and MSE.

Key Words: Prediction Equations, ME Intake, Strain

679 Effect of enzyme supplementation in laying hens on egg weight and commercial egg classification. M. I. Gracia^{*1}, G. L. Campbell², E. McCartney³, J. Peinado¹, and P. Medel¹, ¹Imasde Agropecuaria, S.L., Spain, ²GNC Bioferm, Canada, ³Pen&Tec Consulting, Spain.

Four experiments involving a total of 1,820 laying hens distributed in 108 replicates evaluated the efficacy of an enzyme complex (Endofeed DC, EC No 25) containing 1,100 U/g of Endo-1,3(4)- β -glucanase (EC 3.2.1.6) and 1,600 U/g of Endo-1,4- β -xylanase (EC 3.2.1.8). A completely randomized design was applied in each study using two experimental treatments: 1) basal diet (control), and 2) basal diet with 125 mg/kg of enzyme, the recommended commercial dose. Selected data on egg weight (at 34, 46, and 54 wks of age) were combined in a meta-analysis. The original data used for the statistical analysis were the mean egg weight per replicate, and enzyme supplementation and experiment were considered as main effects. At 46 wks of age enzyme supplementation significantly increased mean egg weight (68.30 vs 66.07 g; $P < 0.001$). At 34 and 54 wks of age, no statistically significant differences were detected between treatments, but hens supplemented with enzyme laid eggs that were numerically heavier than controls (65.90 vs 64.97 g; $P = 0.19$, and 67.76 vs 66.63 g; $P = 0.20$; for 34 and 54 wks of age, respectively). To assess the commercial significance of these improvements, a second meta-analysis was carried out using individual egg weight data at 42 wks of age, obtained from two of the experiments. Each egg was classed according to commercial categories: S (<52.5 g), M (52.5-62.5 g), L (62.5-72.5 g), and XL (>72.5 g). Enzyme supplementation significantly increased the percentage of XL eggs (15.2 vs 5.3 %) at the expense of other commercial categories ($P < 0.01$). In conclusion, the data from these studies suggest that enzyme supplementation improves mean egg weight, allowing classification into larger egg classes.

Key Words: Enzyme Meta-Analysis, Egg Commercial Categories, Laying Hens

680 Enzyme supplementation of laying hens fed diets containing barley and wheat. P. Medel^{*1}, L. Pastrana², J. Méndez³, E. McCartney⁴, and M. I. Gracia¹, ¹Imasde Agropecuaria, S.L., Spain, ²Universidad de Vigo, Spain, ³Coren, S.C.L., Spain, ⁴Pen&Tec Consulting, Spain.

A study was conducted to evaluate the efficacy of a feed enzyme additive (Endofeed DC, EC No 25) containing 1,100 U/g of Endo-1,3(4)- β -glucanase (EC 3.2.1.6) and 1,600 U/g of Endo-1,4- β -xylanase (EC 3.2.1.8) in laying hens. A total of 1,170 Isa Brown laying hens (30-54

wks of age) were allocated randomly to the experimental treatments. A completely randomized block design was applied using two barns (block) and three experimental treatments: 1) basal diet (control), 2) basal diet with 100 mg/kg of enzyme, and 3) basal diet with 125 mg/kg of enzyme. Each treatment was replicated 26 times (13 per barn) with 15 laying hens constituting the experimental unit. From 30 to 38 wks of age, no significant differences were observed. From 38 to 46 wks of age enzyme addition tended to increase egg weight ($P=0.10$) yielding significant differences when comparing control vs 100 mg/kg ($P<0.05$). Also, enzyme supplementation improved feed conversion both per g ($P<0.01$) and per dozen eggs ($P<0.05$). Yolk color was significantly increased in this period ($P<0.01$) and these differences were dose-dependent and linear ($P<0.01$). From 46 to 54 wks of age, enzyme supplementation improved egg weight significantly in a linear, dose-dependent fashion ($P<0.05$), and tended to improve feed conversion per g of egg ($P=0.07$). Enzyme supplementation also increased yolk color ($P<0.01$), improved shell thickness ($P<0.01$) but decreased Haugh Units ($P<0.05$) within this period. For the whole study period, enzyme supplementation improved egg weight by 1.5% (66.60 vs 67.65 g; $P=0.01$), feed conversion by 2.7% (2.05 vs 2.00 g feed/g egg; $P=0.01$), and yolk color in a dose-dependent fashion ($P<0.01$), but control hens tended to have higher Haugh Units than T2 or T3 hens ($P=0.06$). It was concluded that enzyme improves egg weight, feed conversion and yolk color.

Key Words: Glucanase, Xylanase, Laying Hens

681 Evaluation of low-energy diets for a non-feed withdrawal laying hen molt program. P. L. Utterback*, P. E. Biggs, K. A. Rafacz, C. M. Amezcua, K. W. Koelkebeck, and C. M. Parsons, *University of Illinois*.

An experiment was conducted using 504 Hy-Line W-36 hens (69 wk of age) to evaluate several low-energy non-feed withdrawal molting methods. Six treatments provided *ad libitum* access for 28 d to diets consisting of: 1) 47% Low Trypsin Inhibitor soyhulls and 47% corn (LTI-C), 2) 47% Medium Trypsin Inhibitor (MTI) soyhulls and 47% corn (MTI-C), 3) 47% High Trypsin Inhibitor soyhulls and 47% corn (HTI-C), 4) 32% MTI soyhulls, 30% wheat middlings and 32% corn (SH-WM-C), 5) 47% rice hulls and 47% corn (RH50-C), and 6) 25% rice hulls and 68% corn (RH25-C). The seventh treatment consisted of feed withdrawal for 10 d followed by feeding a 16% CP corn-soybean meal diet for 18 d. At 28 d, all hens were fed a 16% corn-soybean meal layer diet and production performance was measured for the next 20 weeks. Hens on the feed withdrawal treatment ceased egg production by Day 8. All other treatments did not reach 0% egg production or ceased production sporadically for one or two days. Body weight loss for hens on the feed withdrawal treatment was 25.8% on Day 10 of the molt period. Hens fed the LTI-C, MTI-C, and HTI-C diets had body weight losses of 17, 18, and 20%, respectively, on Day 28. Hens fed the SH-WM-C, RH50-C, and RH25-C diets had respective body weight losses of 11, 18, and 14% on Day 28. Hen-day egg production was not different ($P > 0.05$) among treatments for Weeks 1 to 24. No consistent differences were observed among treatments for mortality, egg weight, egg specific gravity, feed efficiency, and feed consumption during the 20-wk post-molt production period. When compared to the 10-d feed withdrawal, this research indicates that diets containing soyhulls, wheat middlings, or corn and diets containing combinations of these ingredients are effective non-feed withdrawal methods for molting laying hens.

Key Words: Molt, Laying Hen, Trypsin Inhibitor

682 The effect of supplemental phytase sources on the sparing effect of phosphorus in Pekin ducks. J. K. Rush*, K. M. Banks, K. L. Thompson, and T. J. Applegate, *Department of Animal Sciences, Purdue University*.

Phytate phosphorus (PP) is relatively unavailable to the duck and therefore the majority of the PP that is fed to ducks is excreted. Therefore, an experiment was conducted to determine the effect of supplemental phytase on the sparing effect of phosphorus (P) in Pekin ducks. Drakes were fed 0, 250, 500, 750, or 1000 U/kg phytase (6-15 d) from Eco-Phos. Two reference diets were included that contained 500 U/kg from one of two commercial phytases (A and B) derived from *Aspergillus* and *Peniophora*. Four additional reference diets were also fed (6-15 d) with no supplemental phytase and increasing concentrations of non-phytate phosphorus (nPP) (0.22, 0.29, 0.36, or 0.43 %) to determine P equivalency values of phytase supplementation from improvements in bone

mineralization (6 replicate cages per diet, 4 birds per cage). The nine phytase diets were formulated with 0.22 % nPP and 1.0 % calcium (Ca) (8 replicate cages per diet, 4 birds per cage). Supplementation with 500 U/kg of Eco-Phos improved the P equivalency value based on body weight (BW) gain by 0.147 %. Supplementation with 500 U/kg of phytase B and Eco-Phos improved the P equivalency value based on tibia ash (%) by 0.072, and 0.121 %, respectively. Supplementation with 500 U/kg of phytase B and Eco-Phos improved the P equivalency value based on tibia ash weight by 0.06, and 0.068 %, respectively. When apparent P retention was determined from excreta collected from 13 to 15 d of age, 500 U/kg of phytase B and Eco-Phos improved P retention by 0.048 and 0.092 percentage units, respectively.

Key Words: Phytase, Phosphorus, Duck

683 The availability of energy in meat and bone meal and poultry by-product meal in poultry rations. D. H. Robbins* and J. D. Firman, *University of Missouri-Columbia*.

Meat and bone meal and poultry by-product meal are common by-products used in poultry rations. Unfortunately, the quality of meals varies greatly, making it difficult to precisely measure the nutrient availability. The variability of the above mentioned by-product meals has made it difficult to determine their available energy for utilization by poultry. Several trials were conducted to determine the metabolizable energy (ME) of several meat and bone and poultry by-product meals for both chickens and turkeys. An effort was also made to find an equation that could accurately predict the ME of a by-product meal given its proximate composition. If a simple and consistent method for determining the ME of the feedstuffs could be found, use of meat and bone meal and poultry by-product meal could substantially increase. Briefly, there were few differences found among assay procedures. Species and collection techniques had little impact on the ME values of the feedstuffs. The largest source of variation was the feedstuffs themselves. As mentioned previously, this variability is indicative of animal by-product meals. This made the development of a prediction equation to determine the ME value of meat and bone meals or poultry by-product meals impractical without measurement of gross energy. However, any assay procedure, battery trials or tube feeding, should provide similar results.

Key Words: Meat and Bone Meal, Poultry By-Product Meal, Metabolizable Energy

684 Broiler study nutritional evaluation of b.t.cry1f maize corn from *Bacillus thuringiensis* subsp. *aizawai* and phosphinothricin-n-acetyltransferase. J. L. McNaughton*¹ and L. Zeph², ¹*Solution BioSciences, Inc., Salisbury, MD*, ²*Pioneer Hi-Bred International, Inc. Johnston, IA*.

Two maize (corn) lines have been modified to express both the Cry1F protein from *Bacillus thuringiensis* subsp. *aizawai* and the phosphinothricin-N-acetyltransferase (PAT) protein, referred to as B.t. Cry1F maize lines 1507 or 1360 (Cry1F event TC1507 and event TC1360). Expression of Cry1F and PAT proteins provides control of European corn borer (ECB) and certain other lepidopteran pests, as well as conferring tolerance to glufosinate-ammonium herbicides. A study was conducted to determine the effect of diets containing maize from transgenic Cry1F hybrid maize lines on the performance of commercial broiler chickens (Cobb x Cobb strain) from 0-42 days of age when reared in wire floor cages. Seven reps, containing 5 male broiler chicks per rep, were fed diets containing either Cry1F event TC 1507 and/or event TC1360 and these maize sources were compared to four sources of U.S. corn commercial sources from various feed mill sources in the Eastern U.S. and a positive Control maize hybrid source 7250 (a non-transgenic control maize line). Maize (54.2% in starter and 57.0% in grower rations, across all treatments)- soybean type rations were employed throughout the study and fed *ad libitum* from 0-42 days of age. Prior to adding to rations, hybrid maize kernels from B.t. Cry1F event TC1507 or event TC1360, and control substances were analyzed for expression of the Cry1F protein using a specific ELISA. Cry1F proteins were confirmed to be present in the Cry1F event tC1507 and event TC1360 and absent in the control substances. Based on the results of this study, mortality, mean body weight, and feed conversion were statistically similar ($P<0.05$) among treatment groups. Therefore, maize grain from Cry1F event TC1507 and TC1360 are considered nutritionally equivalent to

maize grain from commercial hybrids when fed to commercial broiler chickens.

Key Words: Maize, Corn, *Bacillus thuringiensis* subsp. *Aizawai*

685 Nutrient composition of peanut meal. N. M. Dale* and A. B. Batal, *Poultry Science, University of Georgia, Athens.*

Solvent extracted peanut meal is becoming increasingly popular as a feed ingredient for poultry. Due to limited availability, levels of inclusion in broiler diets are generally in the range of 3-4%. The ingredient is an especially good source of arginine, while having a low level of lysine. As the origin of nutrient values for peanut meal reported in the standard tables of nutrient composition is unclear, a study was undertaken to document the nutrient composition of peanut meal samples currently available to the poultry industry. Seventeen samples of peanut meal were obtained during 2003 from commercial sources in the southeastern United States. Each was analyzed for proximate composition, true metabolizable energy, and mineral composition. Seven representative samples were analyzed for total and available amino acid content. All values have been adjusted to a 90% dry matter basis, this being representative of the meals evaluated in this study. While considerable variation was noted between samples, a reasonable consistency was observed in samples from each of the five suppliers, reflecting modest differences in processing procedure. Metabolizable energy (TME_n) ranged from 2314-2821 kcal/kg, with a mean of 2663 kcal/kg. Protein ranged from 40.1 to 50.9%, with a mean of 45.0%. Mean values for fat, fiber, and ash were 2.5, 8.7, and 5.2%, respectively. Total concentration and percent availability, respectively, of several critical amino acids were: lysine, 1.58% (85); methionine, 0.53% (88); cystine, 0.66% (80); threonine, 0.58% (81); and arginine, 5.08% (91). Average levels of calcium, phosphorus,

sodium, and potassium were 0.08, 0.56, 0.01, and 1.19%, respectively. The variation observed between samples strongly indicates that confirmatory analyses should be conducted prior to utilizing samples from a new supplier.

Key Words: Peanut Meal, Metabolizable Energy, Protein and Amino Acids

686 Sweet potato as a feed resource for layer production in Nigeria. O. A. Ladokun* and O. O. Tewe, ¹*University of Ibadan, Ibadan, Nigeria.*

A study was carried out on the utilization of sweet potato roots (SPR) as a replacement for maize and sweet potato tops (SPT) as a replacement for wheat bran in layer's diet. 150 point of lay Yaffa birds were fed for 84 days. The SPR was incorporated at levels of 21 and 42% to partially and completely replace maize respectively. The SPT was incorporated at levels of 10 and 20% to partially and completely replace wheat bran. The age at first egg was significantly ($P < 0.05$) different. The birds on the control, laid the first egg at 154 days while those on the complete replacement of maize and wheat bran laid the first egg at 189 days. There was a significant ($P < 0.05$) difference, across the treatments, in the feed intake of the birds, which ranged from 108.77g/bird/day to 127.97g/bird/day. Birds on the control diet had the best hen-day production of 61.83%. The yolk weight did not follow any particular trend but there was a significant ($P < 0.05$) difference across the treatments. Results of the study show that: SPR and SPT can be included in layer diet at not more than 50% of maize and wheat bran respectively. The replacement could be achieved concurrently.

Key Words: Sweet Potato, Replacement, Hen-Day Production

Ruminant Nutrition: Beef and Dairy Calves

687 Calf adipose tissue fatty acid profile, immune function and performance while nursing beef cows consuming high-linoleate or high oleate safflower seed supplements. S. L. Lake*, E. J. Scholljegerdes, E. L. Belden, R. L. Atkinson, D. C. Rule, and B. W. Hess, *University of Wyoming, Laramie.*

Thirty-six Angus \times Gelbvieh calves were used to determine the effect of maternal lipid supplementation on calf adipose tissue fatty acid composition, immune response, and performance. Beginning 3 d postpartum, cows were randomly assigned to be fed hay and a low fat control supplement (CON) or supplements consisting of either high-linoleate cracked safflower seeds (LIN) or high-oleate cracked safflower seeds (OLE) until d 60 of lactation. Cow rations were formulated to be isonitrogenous and isocaloric. Safflower seed supplements were formulated to provide 5% DMI as fat. Calf adipose tissue biopsies were collected near the tail-head region on d 60 of lactation. Calves were injected s.c. with antigen (hen egg albumin) at 21 d of age and again at 48 d of age. Antibody responses were determined in serum; cell mediated immunity was assessed by intradermal antigen injection at 60 d of age. Maternal lipid supplementation did not affect calf adipose tissue content (mg FA/g of adipose tissue) of 14:0 ($P = 0.10$), 15:0 ($P = 0.46$), or 16:0 ($P = 0.12$). Calves nursing LIN and OLE cows had greater content of 18:1 *cis*-9 ($P = 0.05$) than CON calves. Calves nursing LIN cows had greater 18:0 ($P < .0001$), 18:1 *trans*-11 ($P < .0001$), 18:2 ($P = 0.06$), and CLA ($P < .0001$), while OLE calves had greater 18:1 *trans*-9 ($P < .0001$). A trend was noted ($P = 0.10$) for CON calves to have a greater antigen response compared to LIN and OLE calves; however, there was no difference in cell-mediated immune response ($P = 0.86$). Maternal dietary lipid supplementation also did not affect ($P = 0.44$) calf ADG. Adipose tissue content of metabolically important fatty acid was increased in calves nursing lipid-supplemented cows and, although there was a tendency for decreased immune response by these calves, calf ADG was not affected by providing the dam with high-linoleate or high-oleate supplements.

Key Words: Beef calf, Lipid supplementation, Immune response

688 Effect of feeding extruded soybeans to nursing beef cows on conjugated linoleic acid concentrations in adipose tissue of suckling calves. C. Paradis*¹, R. Bertiaume², C. Lafrenière², and P. Y. Chouinard¹, ¹*Universite Laval, Quebec, QC, Canada,* ²*Agriculture and Agri-Food Canada, Lennoxville, QC, Canada.*

The concentration of conjugated linoleic acids (CLA) in meat and milk fat can be increased in ruminants by feeding pasture or extruded soybeans. Nursing calves on pasture have both access to fresh grass and dam milk; the latest being protected against ruminal biohydrogenation by the closure of the oesophageal groove. The objective of this study was to determine the effect of supplementing pasture-fed nursing beef cows with extruded soybeans on the concentrations of CLA in milk fat of cows, and subcutaneous adipose tissue of suckling calves. Thirty-two spring-calving cows and calves were separated in two groups. Cows were distributed in order to have 8 calves of each sex in both groups. Cows and calves were turned out to pasture on June 19 (95 ± 8 days post calving) under a rotational grazing management. Dams received 2 kg/d of full fat soybeans; raw ground (RGSB) for the first group, as a control, and extruded (EXSB) for the second group. Calves were weaned on October 8. The last week before weaning, milk yield of cows was estimated by the weigh-suckle-weigh technique. Milk was sampled for fatty acid (FA) analysis prior to calf nursing. Subcutaneous adipose tissue biopsies were obtained between the 11th and 12th ribs over the longissimus dorsi of the calves. Dietary treatments had no effect on final weight and weight change of cows during the pasture season. Cows fed RGSB tended to produce more milk (5.8 kg/d) than cows fed EXSB (4.1 kg/d) ($P = 0.07$). Weaning weight of calves was not affected by treatments, although the average daily gain tended to be higher for males as compared with females ($P = 0.07$). Milk fat content of CLA increased from 11.2 mg/g of FA in cows fed RGSB to 29.2 mg/g of FA in cows fed EXSB ($P < 0.01$). The CLA concentrations in adipose tissue increased from 17.7 mg/g of FA for calves nursing cows on RGSB to 25.7 mg/g of FA for calves nursing cows on EXSB ($P < 0.01$). Gender had no effect on the CLA concentrations in adipose tissue. Feeding EXSB to cows on pasture increased the concentrations of CLA in subcutaneous adipose tissue of suckling calves by 45%.

Key Words: Conjugated Linoleic Acid, Cow-Calf, Milk Fatty Acids

689 Responses of neonatal calves to milk replacer formulation and pasteurized whole milk. M. Hill*, J. Aldrich, and R. Schlotterbeck, Akey, Lewisburg, OH.

The objective was to compare feeding pasteurized whole milk to feeding milk replacers (MR) formulated using dairy NRC (2001) and Akey guidelines. The whole milk (M) was pasteurized at 72 °C for 15 seconds, quickly cooled and fed immediately. The MR formulated to NRC guidelines (N) was 22% CP from whey and whey protein concentrate (WPC) and 20% fat from edible lard. The MR formulated to Akey guidelines (A) was 20% CP formulated with whey and WPC plus synthetic lysine and methionine, and 20% fat formulated with edible lard plus a vegetable oil blend. Both MR were formulated to contain the same mineral and vitamin contents. Each liquid diet was fed at two levels (1X being equal to a MR powder fed at 454 g as-fed daily=436 g DM daily; 1.2X being equal to 3.8 L of milk, 14.1% DM, 3.2% CP, 3.6% fat=523 g DM daily). The trial used 48 calves (initially 36 kg BW at approximately 3 days of age) that were weaned at 42 days. Data were analyzed as a completely randomized block design with factors of liquid (M, N, A), level of liquid (1X, 1.2X), and the interaction of liquid and level of liquid. Average daily gains from 0-42 days were greatest for A (530 g) and least for N (440 g), with M (483 g) being intermediate ($P < .05$). Average daily gains from 0-56 days were greatest for A (637 g) and least for N (563 g), with M (584 g) being intermediate ($P < .05$). Gains from 0-56 days were greater ($P < .05$) for 1.2X (630 g) vs. 1X (559 g) liquid. Starter (18% CP, 62% corn, .0025% decoquinat) intake from 0-42 and 0-56 days for calves fed M was greater ($P < .05$) than for calves fed N but did not differ ($P > .1$) for level of liquid fed. Feed efficiency was best ($P < .05$) for calves fed A vs. calves fed M and N and for calves fed 1.2X vs. 1X liquid. Abnormal fecal score days were greater ($P < .05$) for calves fed N vs. A and M and for calves fed 1X vs. 1.2X liquid. In summary, calves fed A gained the fastest and were most efficient. Calves fed N gained the slowest and scoured the most. Calves fed 1.2X gained faster and more efficiently than calves fed 1X.

Key Words: Calves, Pasteurized Milk, Milk Replacer

690 Effect of level of starch and Apex botanicals in neonatal calf starter feeds. M. Hill*, J. Aldrich, and R. Schlotterbeck, Akey, Lewisburg, OH.

Previous research in our nursery has shown improvements in calf gains when Apex was fed in all milk protein or soy and milk protein milk replacers (MR). We have observed that gains were improved when Apex was fed via the starter. Additionally, we have observed that high starch (60% corn) starters were used more efficiently by calves than low starch (approximately half of the corn replaced with various of fibrous feeds) starters. Our objective in this trial was to evaluate the addition of .05% Apex 3030 (BFI Innovations) to a high starch (61% corn, 21% soybean meal, 5% distillers grains) and low starch (62% soy hulls, 14% soybean meal, 7% corn, 5% distillers gains) starter (18% CP, .0025% decoquinat, as-fed) when the calves were fed 454 g daily of a 20% all milk protein, 20% fat, .005% decoquinat MR. The trial used 48 calves (initially 41 kg BW at approximately 3 days of age) that were weaned at 42 days. Data were analyzed as a completely randomized block design with factors of starch level, Apex inclusion, and the interaction of starch X Apex. Calves fed the high starch diets grew 11% faster ($P < .09$) and were more ($P < .06$) efficient between 43-56 days than calves fed low starch diets. Calves fed the high starch diets grew 6% faster ($P < .09$) and were 3.6% more efficient ($P < .06$) between 0-56 days than calves fed low starch diets. Calves fed starters with Apex grew 14% faster ($P < .08$) between 43-56 days and 12% faster ($P < .07$) from 0-56 days than calves not fed Apex. Calves fed starters with Apex tended ($P < .14$) to consume more starter from 0-42 days, consumed 10% more ($P < .08$) starter from 43-56 days, and consumed 17% more ($P < .09$) starter from 0-56 days than calves not fed Apex. In summary, calves fed the high starch starter gained 1.2 kg more and were 3.6% more efficient from 0-56 days than calves fed the low starch starter. Calves fed Apex gained 2.4 kg more and consumed 5.3 kg more starter from 0-56 days than calves not receiving Apex.

Key Words: Calves, Starch, Botanicals

691 Effect of feeding neonatal calves selenium yeast or sodium selenite and supplementing specific fatty acids. M. Hill*, J. Aldrich, and R. Schlotterbeck, Akey, Lewisburg, OH.

The objectives were to compare feeding selenium (Se; .3 ppm Se in diets) from either 100% sodium selenite or 100% Se yeast (Lallemand) in the milk replacer (MR) and starter. Additionally we evaluated supplementing a blend of medium chain, 18:2, and 18:3 fatty acids to the MR (FA). The treatments were 1) selenite and no FA, 2) Se yeast and no FA, 3) selenite plus FA, and 4) Se yeast plus FA. Calves were fed 454 g of a 20% all milk CP, 20% all animal fat, .005% decoquinat MR and free-choice 18% CP, 62% corn, 21% soybean meal, 5% distillers, .0025% decoquinat starter. Data were analyzed as a completely randomized design in a 2 by 2 factorial arrangement (Se source and FA) with their interaction. The trial used 48 calves (initially 37 kg at approximately 3 days of age) that were weaned at 42 days. There were no significant ($P > .1$) effects for Se source. Calves supplemented with FA gained 9% faster ($P < .07$) from 0-42 and 0-56 days than non-supplemented calves. Calves supplemented with FA had greater ($P < .01$) starter intakes from 0-42 (28%) and 0-56 (17%) days than non-supplemented calves. Calves supplemented with FA had greater ($P < .07$) hip width changes from 0-42 (8%) and 0-56 (7%) days than non-supplemented calves. Other measurements were not ($P > .1$) significant. Source of Se had no effect on gain, starter intake, or other gross measures in calves up to 56 days. Blood or tissue analysis for Se would have been useful to determine if there were differences in Se status because of Se source. Improvements in gain and starter intake from supplementing specific amounts of medium, 18:2, and 18:3 FA are consistent with five previous trials where the average improvement ($P < .05$) in daily gain from 0-42 days has been 13%.

Key Words: Calves, Selenium Yeast, Fatty Acids

692 Performance and plasma amino acid concentrations of calves on an enhanced-growth feeding program. M. Terré¹, A. Bach^{1,2}, and M. Devant¹, ¹IRTA-Unitat de Remugants, Barcelona, Spain, ²ICREA, Barcelona, Spain.

Thirty-six Holstein and eight crossbred female calves were used in a 2x2 factorial arrangement of treatments to study the effects of level of milk replacer (MR), and addition of a rheological sepiolite for liquid feeding (RSLF) on performance, scour scores, and plasma amino acid (AA) concentrations. The treatments were high MR (HM) or low MR (LM), each of them supplemented with (WS) or without (NS) RSLF. The LM calves were fed 4 l/d of MR at 12.5% DM throughout the suckling period. The HM calves were offered MR at 18% DM: 4 l/d from 1-6 d, 6 l/d from 7-13 d, 8 l/d from 14-33 d, and 4 l/d from 34 d to weaning day at 45 d of study. Calf starter and water were offered ad libitum until the end of the study (94 d). Calves fed HM were heavier ($P < .05$) than LM calves at weaning (69.5 vs 59.0 kg, respectively) and at the end of the study (111.6 vs 102.7 kg, respectively). Starter intake was greater ($P < .001$) for LM than for HM calves until 1 wk after weaning (476 vs 221 g/d, respectively) and similar afterwards. Before day 34 ADG was greater ($P < .001$) for HM calves than for LM (881 and 427 g/d, respectively), but it was lower ($P < .001$) from 34 to 52 d of study (315 vs 707 g/d, respectively). Scour scores were greater ($P < .05$) in HM calves, but HMWS improved ($P < .01$) fecal scores during the highest MR consumption (8 l/d). The positive slope of the regression line that described ADG vs plasma AA concentrations indicated that plasma AA were not limiting growth in HM calves during high MR consumption weeks. However, when MR was reduced to 4 l/d in HM calves, starter intake was insufficient to maintain former ADG. Plasma Lys concentration of LM calves decreased linearly ($R^2 = 0.16$; $P < .05$) as ADG increased during the suckling period, suggesting that Lys could have limited growth. In conclusion, LM calves growth could be limited by Lys supply, whereas the HM treatment seemed to supply sufficient AA to sustain growth while high amounts of MR were fed; but it may limit calves performance due to low starter intake around weaning.

Key Words: Amino Acid, Milk Replacer, Sepiolite

693 A practicum-based course in equine parturition for undergraduate students. P. L. Ryan*, D. L. Christiansen, R. M. Hopper, S. T. Willard, S. D. Bowers, T. W. Dickerson, and G. L. Olsen, *Mississippi State University, Mississippi State.*

The objective of this exercise was to develop a practicum-based pilot course to instruct undergraduate students interested in equine reproduction with specific emphasis on the pregnant mare, parturition and post-natal foal. The course was offered as a Special Topics in Animal Science, but open to students from across campus with an interest in the equine species. Forty three students enrolled (4 freshman, 10 sophomore, 8 junior and 21 senior) representing six majors. The course offered a weekly lecture and six nights of foal-watch duty for a total of two credit hours. Students worked in pairs, assisted with the birth process and performed the post-partum treatments of the foal. Students were required to maintain detailed records in the foal-watch log book of activities related to mare behavior, udder development, time of delivery, time from delivery to foal standing and suckling, and whether there were complications (i.e., dystocia). For credit, students had to complete six nights of duty, attend the weekly lecture and write a report on their experiences while on foal-watch duty. At the conclusion of the course, a course evaluation was conducted to assess student perceptions of the course as a whole. Evaluations were conducted on the basis of a 1 to 5 scale (1 = strongly disagree and 5 = strongly agree) and were analyzed to ascertain the value of lectures and the hands-on experience during foal-watch. Thirty six of the forty three students enrolled responded (83.7%). The course evaluation revealed that the students felt that the course was relevant to equine sciences (4.83 ± 0.07), that lectures complimented the practicum exercises (foal-watch; 4.50 ± 0.12), that they learned a lot from the course (4.17 ± 0.17), and that what they learned would have useful application later in life (4.64 ± 0.11). The students agreed that having more than one instructor team-teaching the course was good (4.28 ± 0.14) and students disagreed that the different teaching styles were distracting (2.11 ± 0.17). There was agreement (4.80 ± 0.12) that the pilot course should be recommended to the university curriculum committee for development as a practicum-based course in the equine sciences.

Key Words: Undergraduate, Teaching, Equine Practicum

694 Withdrawn by author. . .

695 Dairy management symposium training: Instructive partnership between academia and industry. A. Ahmadzadeh* and M. A. McGuire, *University of Idaho, Moscow.*

The traditional educational mechanism cannot provide adequate interaction with industry professionals for up-to-the-minute knowledge about dynamic changes within the dairy industry. The goal of the described educational activity was to provide complementary instruction in a senior level dairy management course to 1) enhance student knowledge and professional competencies for the progressive and challenging dairy industry and 2) to share knowledge and experience of institutional partners, producers, and allied industry experts. Through the semester, the team-taught course provided a foundation in dairy management. To achieve the goals, a mini-symposium occurred at the end of the semester.

Contemporary and Emerging Issues: Current and Future Prospects for Animal Nutrition Management for Environmental Impact Reduction

697 Use of mass balance techniques for nutrient excretion modeling. T. J. Applegate*¹ and R. Angel², ¹*Department of Animal Sciences, Purdue University,* ²*Department of Animal and Avian Sciences, University of Maryland, College Park.*

In the absence of comprehensive biological data on total excreted nutrients, development of models is needed to predict these values for livestock species. Models are usually constructed based on relationships that have been determined biologically and allow for estimation of undetermined values. Estimation of nutrient excretion has become necessary due to the recent emphasis on environmental management and regulation of animal feeding operations. Because of the impact that new environmental regulations will have on animal production it is important to determine if model estimates are accurately predicting biological nu-

trient excretion rates. The majority of current models for estimation of nutrient excretion have largely been derived from a process-based modeling approach, an approach that utilizes known analyses of components (feed analyses, tissue deposition and/or growth, product nutrient composition, average apparent retention, etc.). This mass-balance modeling approach has inherent errors, including: extrapolation of data to other ages, lack of input data for different feeding programs, and unknown referenced inputs for up-to-date industry feeding practices and productivity. Nevertheless, the mass balance approach has been critical in identifying gaps in the existing literature. Models utilizing multivariate least-squares regression may be developed in the future, but knowledge

Key Words: Interactive Learning, Cooperative Partnership, Allied Industry

696 Development of a distance education based food safety microbiology course in poultry science. R. S Hardin*, E. M Hirschler, M. M Kundinger, A. R Sams, and S. C Ricke, *Texas A&M University, College Station.*

With the increasing demand for food safety the responsibilities of food industry personnel has increased. More responsibility requires advanced training, which may not be readily available onsite. Distance education courses have become popular due to the increased number of commuter students as well as people already in the workforce who need more background on foodborne disease. In many cases the ability to physically attend a class at a university that offers such courses and academic expertise can be limited. Therefore a graduate level web based course entitled Special Topics-Poultry Food Safety Microbiology was developed from an existing senior undergraduate advanced food microbiology course in the Poultry Science Department at Texas A&M. Even though the use of the Internet as a teaching tool is becoming more prevalent, converting this course into a distance education course provides some unique challenges, to maintain comparable course content in an asynchronous manner. The overall objective for this course was to examine all aspects of foodborne bacterial activities including ecology in food, animals, raw and processed meat, eggs, and human pathogenesis. To create a graduate level learning experience for the students a research paper assignment was developed in order to provide a more in-depth learning opportunity of microbial pathogens. The writing process was completed through electronic submission of an outline, rough draft, and finally completing a fifteen-page scientific paper related to a food microbiology topic of interest. This instructional approach imparts an effective means for distance education students to extend an understanding of food microbiology.

Key Words: Food Safety, Distance Education, Poultry Science

of the effects of independent variables is relatively unknown at this time for most livestock species.

Key Words: Nutrient Management, Excretion Models, Mass Balance

698 Interactions between indigenous gut microbiota and animal waste production. J. A. Patterson* and A. L. Sutton, *Purdue University, West Lafayette, IN.*

The importance of the ruminal microbiota in altering the form of feed nutrients during ruminal digestion is well known, however, there has been increased interest in the interactions between the hindgut microbiota and diet in altering animal waste emissions. The primary waste emissions include methane, ammonia, phosphorous and odors. The fundamental microbial processes are similar between the rumen and hindgut, yet the microbial populations and their activities are dictated by differences between the two ecosystems. Examples of the influence of diet on animal waste emissions include reduction of methane emissions in ruminants by feeding monensin or high grain diets and reduction of urea/ammonia excretion in nonruminant animals by lowering dietary crude protein and supplementing with synthetic amino acids. Nutrient digestion has been increased by inclusion of enzymes and phosphorus excretion has specifically been reduced by inclusion of various sources of phytase. Composition and emission of odorous compounds are also affected by diet and microbial activities. Alteration of the intestinal microbiota and their activities will be an important method of reducing animal waste emissions in the future. One may also be able to manipulate the intestinal microbiota to enhance useful products derived from animal waste.

Key Words: Intestinal, Microbiota, Animal Waste

699 Historical and current perspectives of nutritional formulation in swine and poultry to reduce environmental impact. G. Allee*, *University of Missouri, Columbia.*

In past years diets for pigs and poultry were formulated on the basis of crude protein, total phosphorus, with a margin of safety added to ensure a nutrient was not limiting. Little, if any, attention was given to excretion of nutrients. In todays formulations, diets are formulated on an available amino acids, available phosphorus basis at the requirement level for the various nutrients with tremendous emphasis being placed on the excretion of nutrients into the environment. Historically pigs were fed a starter, grower, and finisher diet sequence. Today it is a normal practice to change diets frequently (3 or 4 starter diets, two grower diets and three finisher diets) in order to minimize the feeding of excess nutrients. It is well established that dietary manipulation is a very effective method to reduce the environmental impact of poultry and swine production. By using crystalline amino acids and the concept of ideal protein reduced crude protein corn-soybean diets greatly reduces nitrogen excretion. By using these concepts in formulation nitrogen excretion can often be reduced 20 to 30% without influencing growth performance, carcass value or cost of production. In typical corn-soybean meal diets, two-thirds of the phosphorus is bound as phytic acid, making it unavailable to pigs and poultry and consequently excreted. By using a phytase enzyme or low-phytate corn and formulating diets on an available phosphorus basis phosphorus excretion can be reduced 20 to 30%. The use of both low-phytate cereals and phytate enzyme can reduce phosphorus excretion 40 to 50%. Other examples will be given to demonstrate that dietary manipulation is a very effective method to reduce the environmental impact of pig and poultry production.

Key Words: Swine, Poultry, Phosphorus

700 Reducing environmental impact of cattle through precision feeding. D. G. Fox*¹, T. P. Tylutki¹, L. O. Tedeschi¹, and P. E. Cerasolett², ¹*Cornell University, Ithaca, NY*, ²*Cornell Cooperative Extension, Hamden, NY.*

Excess dietary N is volatilized or leached into ground and surface water and excess dietary P is lost through runoff or accumulated in the soil over time where it is subject to loss in watercourses. The risk of air and water pollution increases when nutrient imports greatly exceed nutrients exported as meat or milk (positive mass balance). Our studies on dairy and beef farms indicated over two thirds of the N and P imported as feed were not exported as feed or products (meat and milk). Precision feeding

involves using mathematical models to implement research-based knowledge to formulate diets and feed management programs that optimize production while minimizing nutrients in manure. Precision feeding also requires using management practices that ensure the diets consumed are as close as possible to those formulated. In our case studies on dairy farms, precision feeding with the Cornell Net Carbohydrate and Protein System (CNCPS) reduced N and P excretion by an average of 33% while reducing annual feed costs by 50 to 130/lactating cow. Precision feeding reduced N and P mass balance on a case study farm by 17 and 28%, respectively. In another study in the basin of a P restricted reservoir, reducing P excretion by 33% with precision feeding reduced dairy farm mass P balance by 50%. The CNCPS model was used to evaluate the impact of advances in research-based knowledge on precision feeding. The bias in predicting feed energy values, which are used to predict diet allowable milk and growth and dietary N and P requirements, was reduced from -11.4 to 0.4 % and the variation accounted for was increased from 61 to 80% by using the CNCPS mechanistic rumen model rather than tabular values. The use of bST was predicted to produce the same amount of milk with fewer cows and 8% less N and 12% less P in the manure. We estimated that ionophores have reduced N excretion by 9.8 Gg/yr in feedlot cattle and would reduce N excretion by 67 Gg/yr if fed to lactating dairy cattle in the US.

Key Words: Environment, Nutrient Management, Modeling

701 Environmentally friendly feeds: manipulations of diets and feeding to reduce environmental impact from intensive aquaculture. G. Fornshell*, *University of Idaho, Moscow.*

The potential negative environmental impact of aquaculture effluents has received considerable attention from regulatory agencies and non-governmental organizations over the past decade. Aquaculture production systems such as net-pens and raceways where the culture water is readily exchanged with or continuously discharged into the surrounding environment have received the most attention. Feed is effectively the only major source of aquaculture-derived nutrients, such as nitrogen and phosphorus, and solids from these systems that can lead to eutrophication and sedimentation. To reduce the environmental impact of aquaculture effluents several dietary manipulations have been developed to minimize metabolic waste production, maintain product quality and maximize growth efficiency of the fish. This talk reviews the approaches taken including diet formulations, ingredient processing, genetic selection of fish and plants, manufacturing processes, and feeding strategies that have lead to considerable reductions in metabolic wastes and solids. Feed represents the largest single variable cost of production. As such, the efficient use of high-quality feeds is essential for productivity, economic efficiency, and protection of the environment.

Key Words: Environment, Feeds, Aquaculture

702 The history and current perspectives of dietary formulation in the horse. L. Lawrence*, *University of Kentucky, Lexington.*

When the most recent NRC recommendations for nutrient intakes of horses were published in 1989, the values represented minimum nutrient amounts for normal activity and health. In many cases, the nutrient amounts recommended by the 1989 NRC are much lower than amounts fed to horses in practical environments. The natural characteristics of some common feeds can result in nutrient excesses. Grass and legume hays are staples in most horse diets but because of their high potassium content, they result in potassium intakes far above the needs of most horses. The advantages of high forage diets (behavior and gastrointestinal health) outweigh any physiological disadvantages of feeding excess potassium. In addition, because it is difficult to measure optimal performance in horses, diets for horses are often formulated to provide nutrient intakes above the NRC (1989) recommendations. Most of the concentrates fed to horses in the U.S. are formulated for use with hay or pasture. Because forages can vary, commercial concentrates may be formulated to provide adequate nutrition even when low quality forages are used. Excess nutrient intakes can occur when these feeds are used with high quality forages. One approach to reducing nutrient excretion by horses would be to use feed ingredients with high nutrient availability or to include feed additives that enhance nutrient availability. Unfortunately, there have been few studies in this area and more research will be necessary to evaluate feeds and feed additives. Another approach to

minimizing nutrient excretion by horses is the use of commercially manufactured feeds that complement specific forages. For example, when alfalfa hay is used, the amounts of protein and calcium included in the concentrate can be significantly reduced. However, horse owners often have difficulty distinguishing among forages, making the successful application of this approach difficult. The approach with the most potential to reduce nutrient excretion by horses would be enhanced education of horse owners to improve their understanding of how to effectively match feed characteristics with the nutrient requirements of horses.

Key Words: Equine, Waste Management, Nutrient

703 Development of on-farm treatment of animal waste. J. B. Carey*, *Texas A&M University, College Station.*

Development of new and alternative on-farm systems to manage waste must address several obstacles or issues in order to have significant potential for adoption by producers. A primary obstacle is time. The new or alternative method must involve a reduction in the amount of time needed for waste management or at least no increase in time required to address waste management duties. Another issue to address is cost. Obviously, any method that actually reduces costs would be considered favorably. However, it is essential that all costs be considered including any potential costs of marketing final products. Additionally, new or alternative methods must prove effective and reliable under field conditions. If extensive training, monitoring, or non-traditional skills are needed for success then the applicability to commercial settings will diminish. Reliability also includes the assurance of consistent performance and accomplishment of the waste management tasks under all field conditions utilizing the skill sets available among producers and farm workers. It is also important that the new or alternative method produce an advantage or benefit, economic or otherwise to the producer. This can range from reduced pressure on existing methods to financial returns. If producers are expected to adopt new technology or change practices, they must perceive a benefit. While this list of issues and obstacles is not exhaustive, it provides a basis for consideration of new and

alternative waste management technologies. Methods such as on-farm composting and marketing of manure or litter require full consideration of these issues. Mortality management alternatives such as acid or alkaline preservation, in-vessel composting and similar technologies require broad cooperation among a wide range of scientific and professional disciplines in order to adopt a research concept to a workable on-farm solution to waste management issues.

704 Alternative uses and value added processing of animal waste products. C. M. Williams*, *North Carolina State University, Raleigh.*

Traditional animal waste treatment generally involves on-farm land application of manure as a source of plant nutrients. Although cost effective, such practices may not be sustainable in some regions that produce large quantities of meat, eggs and milk. Technologies that provide economically feasible alternative strategies for processing large quantities of manure and generating marketable value-added products are needed. Some processes identified as potentially effective include centralized processing of manure to generate bio-based energy (methane), diesel fuel, and ash for a granular fertilizer product. Examples of work in progress to accomplish these objectives include high solids anaerobic digestion (HSAD), bio-methanol production, and fluidized bed combustion. The HSAD produced approximately 12 decatherms of methane per ton of feedstock and post-processed material met Class A biosolids requirements for fecal coliform bacteria. The bio-methanol plant capacity is approximately 7,500 gallons of methanol daily from a manure feedstock from 12 farms containing 12,000 finishing pigs each. The methanol is railed to a refinery for biodiesel fuel blending. A combustion study processing approximately 90 tons of combined swine biosolids and turkey litter showed that the fluidized bed technology at combustion temperatures above 1,600° F resulted in efficient combustion and low emissions of carbon monoxide, and minimal emissions of criteria pollutants. Collectively, these technologies demonstrate potential new and off-farm alternatives for processing animal waste products.

Food Safety: Alternatives to Antibiotic Use

705 Control of *Salmonella* in poultry production, the European experience - can it be adapted to the US? J. S. Bailey*¹ and T. Roberts², ¹*Agricultural Research Service, USDA, Athens, GA*, ²*Economic Research Service, USDA, Washington, DC.*

Sweden and Denmark have instituted programs which have significantly controlled *Salmonella* in broiler chicken production. Sweden's program was initiated about 15 years ago and Denmark's program was started about 10 years ago. In both programs, extensive testing programs are in place, no *Salmonella* positive feed is allowed, and all breeder birds that test positive for *Salmonella* are eradicated. In Sweden the program is continued for final grow-out and no *Salmonella* positive birds are allowed to be sold to the consumer and any *Salmonella* positive flocks are killed and disposed of. In Denmark, *Salmonella* positive grow-out broilers are processed separately, but can be sold to the consumer. Initially the costs of implementing the programs in both Sweden and Denmark were paid for by the government. Sweden has moved to a program that is self insured through industry check-offs. Denmark is attempting to implement a similar insurance program. Final economic analysis for a similar program in the U.S. is ongoing, but it will likely not be economically feasible to implement this same program in the U.S. However, alternative methods of achieving similar results may be possible. The use of live and killed cell vaccines in breeders, competitive exclusion treatments in breeders and broilers, and extensive biosecurity in breeder and broiler operations should yield similar results without the extensive costs of eradication programs. Intuition would suggest and the European experience has confirmed that the best way to control pathogens like *Salmonella* in food systems is to control the pathogens on the farm and to prevent them from ever entering the processing plant.

Key Words: Broiler, *Salmonella*, Control

706 Use of competitive exclusion to control enterotoxigenic strains of *E. coli*. R. B. Harvey*, R. C. Anderson, K. J. Genovese, T. R. Callaway, and D. J. Nisbet, *Food and Feed Safety Research Unit, ARS-USDA, College Station, TX.*

Foodborne diseases, morbidity, and mortality in food-producing animals, associated with pathogenic strains of *Escherichia coli*, are of public health and economic significance. Increasingly, *E. coli* have become resistant to most antibiotics and alternative control measures are sought. Our laboratory developed a defined culture of commensal bacteria of porcine GI tract origin, maintained it in continuous-flow culture, and designated it as RPCF. When administered to neonatal gnotobiotic pigs, immunoglobulin levels were increased 20- to 100-fold. *In vitro* laboratory studies have shown that RPCF prevented colonization of O157:H7 and F-18 strains of *E. coli*. Other laboratory studies demonstrated that RPCF-treated pigs had decreased mortality and bacterial shedding compared to controls when challenged with enterotoxigenic strains of *E. coli*. In field trials involving five geographically separated nursery farms with a history of high mortality from F-18 strain of *E. coli*, piglets were orally administered 10⁸ CFU of RPCF within 24 h of birth, were monitored throughout the nursery period, and the performance of RPCF-treated pigs were compared to a similar number of untreated pigs on the same farms. A total of 34,676 pigs were included in these trials. We observed decreased medication costs and a 3.53% decrease in nursery barn mortality in RPCF-treated pigs compared to controls. There was an annual cost benefit of \$22,196 per farm due to improved livability and reduced medication. Results from the present studies indicate that under laboratory and field conditions, RPCF was effective in controlling disease induced by enterotoxigenic *E. coli* and may be a viable alternative to the use of antibiotics.

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Key Words: Pathogenic *E. Coli*, Alternative to Antibiotics, Mortality

707 Strategies to reduce *Campylobacter*. Norman J. Stern^{*1}, E. A. Svetoch², B. V. Eruslanov², Y. N. Kovalev², L. I. Volodina², V. V. Perelygin², E. V. Mitsevich², I. P. Mitsevich², V. D. Pokhilenko², V. N. Borzenkov², V. P. Levchuk², O. E. Svetoch², and T. Y. Kudriavtseva², ¹USDA-ARS-Russell Research Center, Athens, GA, ²State Research Center for Applied Microbiology, Obolensk, Russia.

We evaluated anti-*Campylobacter* activity among 11,790 isolates of lactic acid bacteria from poultry production environments. We measured zones of *C. jejuni* inhibition surrounding the candidate strains and observed 279 isolates exhibiting antagonism. A *Lactobacillus salivarius* strain PVD32, was identified and deposited under provisions of the Budapest Treaty (NRRL B-30514). The cell-free, ammonium sulfate precipitate from the culture was termed the crude antimicrobial preparation (CAP). A zone of *C. jejuni* growth inhibition surrounding 10 ul of the CAP was observed. *C. jejuni* growth resumed when the CAP was pre-incubated with protease enzymes, thus demonstrating the peptide characteristic consistent with bacteriocin definition. The bacteriocin was further purified using a combination of ammonium sulfate precipitation, CM-Sepharose, Superose, and ion exchange chromatography. SDS-PAGE electrophoresis provided an estimated molecular weight of 6 KDa. MALDI-TOF analysis refined the molecular weight as 5,123 Da. The isoelectric point of the active fraction was determined at a pH of 9.0. The amino acid sequence of the bacteriocin was determined. The bacteriocin activity was stable following exposure to 90°C for 15 minutes. The moiety was purified and encapsulated in polyvinylpyrrolidone (PVP), and added to feed at levels of 250 mg/Kg feed. Day of hatch chicks were colonized with *C. jejuni*; log 10 cfu/gm feces mean levels in untreated, 7-day old control chicks was 6.21, while birds provided bacteriocin in feed 3 days prior to sampling was 1.98; untreated, 10-day old control chicks were colonized at a means of 8.99 and treated birds were colonized at 0.61. Among an additional 14 trials, comprised of 290 chickens, of varying ages, with varying amounts of bacteriocin administered, and challenge strains of *C. jejuni*, we consistently observed at least a one-million fold reduction in cecal levels among treated birds. The bacteriocin from this *L. salivarius* appears useful to control *C. jejuni* in poultry.

Key Words: *Campylobacter*, Poultry, Bacteriocin Therapy

708 Strategies to reduce *Clostridium perfringens*. G. R. Siragusa^{*}, Agricultural Research Service, USDA Russell Research Center, Athens, GA.

In the context of poultry production, *Clostridium perfringens* (*Cp*) represents both a potential food borne pathogen as well as a significant poultry disease. As a human food borne disease agent, this spore forming pathogen has accounted annually for over 248,000 total cases of food borne disease in the United States alone. As illnesses caused by this pathogen are not part of an active surveillance program in the U.S., the aforementioned figure is estimated to be a tenfold under reporting. Within the context of production, *C. perfringens* necrotic enteritis (NE) is a peracute disease associated with predisposing factors including coccidial infections, feed types and environmental stresses. Complete withdrawal of antibiotic growth promoters from feed is one factor strongly associated with NE. This presentation will present newly initiated research to both develop alternatives to antibiotics to control *Cp* in the live bird but also research into our current understanding of gut microbial ecology preceding this disorder. Our lab has been successful in isolating a number of bacteriophage lytic for *Cp*. These virions display a highly narrow spectrum of activity against different *Cp* strains however; it is noteworthy that they show a high level of variation in plaque morphology. Work is ongoing to isolate, purify and clone the phage lytic enzyme responsible for the lysis activity and for potential use as either a therapeutic or prophylactic agent in live production. Work is also underway to identify and characterize bacteriocins for the purposes of *Cp* control. This effort has so far resulted in strains of *Cp* which produce bacteriocins against other non-producing strains. The quantitative profiling of the gut flora during growout is a goal so far achievable only on a small sample basis. Work is underway to develop sets of tools based on non-cultural methodology that can be applied to large numbers of samples thereby enhancing the diagnostic and accuracy of a general gut microbial profile. Results from other antibiotic alternative strategies to control *Cp*, e.g. sodium chlorate, as well as a review of the potential role of quorum sensing in gut modulation of specific pathogens will be presented.

Key Words: *Clostridium perfringens*, Lytic Bacteriophage, Bacteriocins

Women and Minority Issues in Animal Agriculture Symposium

709 Gender and animal agriculture. C. Sachs^{*}, *Rural Sociology and Women's Studies, Penn State University, University Park.*

Women have become increasingly involved in agriculture in the U.S. in recent years. More women are farming on their own, while others are more involved in decision-making with their spouses or other agricultural partners. Women farmers are more likely to be involved in animal agriculture than in crop production. Also, women on farms extensively participate in farm tasks and decision-making related to livestock. This paper will use data from a national survey of 2,661 farm women collected in 2001 to understand the extent of women's involvement in farm tasks, farm decision-making, and off-farm work. This study will report differences in women's involvement in tasks and decision making in livestock production by type of farm, type of livestock, sociodemographic characteristics of farm women, and region.

710 A respect for the land. A. J. King^{*}, *University of California - Davis.*

Historically, Japanese, Chinese and Mexican Americans have made valuable contributions to farming in the West. Today, many Hmong families

have leased lots of a few acres in Washington and California to raise specialty crops that are sold at local farmers markets. There are also populations of East Indians growing several different types of row and fruit crops in Northern California. The number of African American farmers is significant when focusing on the West and the Midwest. Minority groups (African Americans, American Indians, Chinese, East Indians, Hispanics, Hmong, Japanese, Laotians and women) who choose farming as careers continue to face obstacles while contributing in several ways to the ample and diverse food supply produced in the Western United States. What are these obstacles, their similarities and differences? What unique contributions have been made to farming processes and distribution related specifically to animal agriculture? How are minority farmers redefining the profile of animal agriculture and engagement by grassroots organizations?

Key Words: Minority Farmers, Animal Agriculture, Obstacles and Contributions

Animal Health - Growth and Immunity

711 Preliminary evaluation of the efficacy of halofuginone lactate (Halocur[®]) as an aid in the prevention of cryptosporidiosis in Ontario dairy calves. B. D. Jarvie, K. E. Leslie^{*}, A. S. Peregrine, T. F. Duffield, and J. Scott Weese, *University of Guelph, Guelph, ON, Canada.*

Cryptosporidium parvum is a common cause of diarrhea in neonatal calves. The incidence of shedding of *C. parvum* and clinical disease is

high on many dairy farms. There are currently no approved products in North America for the prevention of cryptosporidiosis. In Europe, halofuginone lactate (Halocur[®]) is marketed for the prevention of cryptosporidiosis. The objective of this study is to evaluate the efficacy of halofuginone lactate as an aid in the prevention of cryptosporidiosis in dairy calves. Commercial dairy farms participated in this study from February to July 2003. A total of 509 replacement heifer calves from 24 farms were enrolled and randomly assigned to one of two groups.

The treatment group received 5 mg of halofuginone lactate orally once daily for the first seven days of life. The control group received an equal volume of 10 ml of a placebo solution, administered in an identical manner. Fecal samples were collected from 305 calves on a weekly basis for the first three weeks of life at 3 to 9 days, 10 to 16 days, and 17 to 23 days of age. Fecal samples were collected from another 202 calves once between 14 and 21 days of age. Feces were analyzed for the presence or absence of *C. parvum* oocysts using sucrose flotation and microscopy. The prevalence of isolation was significantly ($p < 0.05$) reduced in halofuginone lactate-treated calves (39%) as compared to placebo-treated calves (50%). In the subset of calves sampled for three consecutive weeks, there were significant ($p < 0.05$) differences between treatment groups in the incidence of *C. parvum* detection during the three weeks of the study. In the overall study population, halofuginone lactate treatment resulted in a significant decrease in mortality up to three weeks of age ($p < 0.05$). In summary, halofuginone lactate has considerable promise as an aid in the prevention of *C. parvum* isolation in Ontario dairy calves.

Key Words: *Cryptosporidium parvum*, Halofuginone Lactate (Halocur[®]), calf Diarrhea

712 A yeast cell-wall derivative and ascorbic acid fed to neonatal dairy calves is protective against enteric challenge with *Salmonella dublin*. D. C. Cary^{*1}, S. D. Eicher², J. A. Patterson¹, and T. A. Johnson¹, ¹Purdue University, West Lafayette, IN, ²USDA-ARS, West Lafayette, IN.

Salmonella dublin frequently causes morbidity and mortality in dairy calves during the first weeks of life. The objective of this study was to examine the efficacy of beta-glucan and ascorbic acid for protection against a *S. dublin* challenge. Thirty-eight bull calves, 3 to 10 days of age, were transported for 4 h, then placed into one of three treatment groups: Immuno-gain, a product containing 2% beta-glucan and ascorbic acid (IG); a purified beta-glucan plus ascorbic acid (BG); and a control (CTL). On day 21, all calves received an oral challenge of 4.28×10^8 CFU *S. dublin*. BW were recorded post-d 0 transport, pre-challenge (d 21), and pre-d 42 transport. Weekly wither heights, feed intake, temperature, average fecal scores, and fecal shedding of *Salmonella* were recorded. Temperatures were taken twice daily, for one week after the challenge. All calves began the study positive for *Salmonella* (non-*S. dublin*). By day 14, shedding of *Salmonella* by BG calves had decreased compared to IG ($P < .05$) and CTL ($P = .15$). Shedding was negligible at the time of *S. dublin* challenge. All groups increased shedding after challenge, with no difference among groups. All calves were negative for fecal *Salmonella* by d 42. BG temperatures peaked at 96 h through 120 h, IG temperatures peaked at 72 h, and CTL temperatures showed a bimodal peak, at 48 and 96 h. At 48 h, the CTL with temperatures higher than 40C (normal=39C) tended to be more than IG ($P = .12$). Mortality tended to be lower ($P < .10$) in IG than BG prior to challenge (8%, 36%), and lower ($P < .10$) than BG and CTL after challenge (8%, 36%, 17%, respectively). There were no significant differences in growth measures of weight or height. Feed efficiency (weight gain/feed intake) was significantly higher in IG than BG ($P < .01$) and CTL ($P < .01$) prior to *S. dublin* challenge on d 21. There was no difference in final feed efficiency. Results indicate that ascorbic acid plus yeast cell wall derivatives containing beta-glucan may provide protection during enteric challenge.

Key Words: *Salmonella dublin*, Beta-Glucan, Ascorbic Acid

713 Dietary protein and energy and the adaptive immune response of milk replacer-fed dairy calves. M. R. Foote^{*1}, B. J. Nonnecke², W. R. Waters², M. V. Palmer², M. A. Fowler³, B. L. Miller⁴, and D. C. Beitz¹, ¹Iowa State University, Ames, IA, ²National Animal Disease Center, ARS, USDA, Ames, IA, ³Land O'Lakes, Inc., St. Paul, MN, ⁴Land O'Lakes, Inc., Webster City, IA.

We have shown previously that increased protein and energy affect specific aspects of immune function. Effects of enhanced nutrient availability on adaptive immune responses, however, have not been studied. Using a *Mycobacterium bovis*, Bacille Calmette-Guerin (BCG) sensitization/purified protein derivative (PPD) challenge model, we have shown that neonatal calves, relative to adult cattle, have robust cell-mediated immune responses and weak antibody responses to antigen. The present study examined the effects of increased protein and energy provided by a commercial, intensified milk replacer on the adaptive (i.e. antigen-specific) immune response of the calf. Holstein bull calves were fed a

standard (ST, 0.57 kg/d of a 22% CP, 20% F milk replacer, n=11) or intensified (IN, 1.14 kg/d of a 28% CP, 20% F milk replacer, n=11) diet from 1 to 7 wk of age. Calves were vaccinated with BCG at the initiation of the study (i.e. approximately 1 wk of age). Average daily gain was greater ($P < 0.0001$) for IN (0.62 kg) than ST (0.29 kg) calves. Liver, thymus, and subcervical lymph nodes from IN calves were heavier ($P < 0.05$) than ST calves. Total leukocyte numbers, serum IgG, IgM, and IgA levels and cutaneous reactions to antigen were affected by age but not by nutrition. Mitogen-stimulated blood mononuclear cells (PBMC) from IN calves produced less ($P < 0.05$) IFN- γ and more ($P < 0.05$) NO than PBMC from ST calves 5 wk after vaccination, as reported previously. Antigen-induced IFN- γ and NO production by PBMC, however, were unaffected ($P > 0.05$) by nutritional plane. TNF- α production of non-stimulated and PPD-stimulated PBMC from IN calves was decreased ($P < 0.05$) relative to responses of cells from ST calves 5 wk after vaccination. These results suggest that antigen-specific responses of vaccinated calves are affected minimally by feeding an intensified milk replacer that is available commercially.

Key Words: Calf, Nutrition, Immune Function

714 Pro- and anti-inflammatory cytokine responses in endotoxin challenged bovine macrophages. J. A. Mills^{*†}, J. E. Campanicki, and R. M. Dyer, Department of Animal and Food Sciences, University of Delaware, Newark.

Endotoxin (LPS) induced inflammatory responses are a complex process mediated by a number of cytokines. A balance of pro-inflammatory and anti-inflammatory cytokines during endotoxin exposure avoids over production of pro-inflammatory cytokines and the resultant widespread tissue damage and dysfunction of the microcirculation. Accordingly, we proposed bovine macrophages respond to LPS by expressing both pro- and anti-inflammatory cytokines. Bovine alveolar macrophages (n=3) were challenged with LPS (1mg/ml) (*E. coli*: O111:B4) and mRNA expression for IL-1 α , IL-1 β , TNF α , IL-10, IL-12, IL-18, TGF β and iNOS was determined by real time QPCR at 1.5, 12, 24 and 36h. Expression of all cytokines and iNOS increased post LPS challenge ($P < 0.05$). IL-1 α , IL-1 β , TNF α and iNOS expression peaked in LPS exposed cells at levels 11.3, 19.7, 6.5 and 11.3 fold higher ($P < 0.05$) than unexposed cells after 24h. By 36h, levels of TNF α and iNOS expression in LPS exposed cells decreased 6.5 and 3.5 fold below ($P < 0.05$) unexposed cells while IL-1 α and IL-1 β remained elevated 2.5 and 9.8 fold above unexposed cells ($P < 0.07$). IL-10 and IL-12 expression peaked to levels 6.1 and 24.3 fold higher ($P < 0.05$) in LPS exposed cells compared to levels in unchallenged cells after 1.5h. By 36h, IL-10 expression significantly decreased to a level 2.8 fold lower ($P < 0.05$) than unexposed cells. TGF β expression peaked ($P < 0.05$) at levels 2.6 fold above those in unexposed cells after 12h; however, decreased 2.1 fold below levels in unexposed cells by 36h. The data indicated LPS activated expression of a mixed pro- and anti-inflammatory cytokine response in bovine macrophages. The early mixed response entailed expression of the pro-inflammatory cytokines IL-1 α , IL-1 β and IL-12 and the anti-inflammatory cytokine IL-10. Later, the mixed responses lead to expression of the pro-inflammatory cytokines IL-1 α , IL-1 β and TNF α and the anti-inflammatory cytokine, TGF β . Expression of IL-1 α and IL-1 β was sustained throughout the LPS challenge while expression of all other cytokines and iNOS was depressed below levels in unexposed cells by 36h.

Key Words: Cytokines, Endotoxin, Alveolar Macrophages

715 Are polymorphisms within the interleukin-8 receptor (CXCR2) gene linked to altered neutrophil function? G. M. Pighetti^{*†}, M. Rambeaud, S. M. Youngerman, and A. M. Saxton, The University of Tennessee, Knoxville.

Recent work within our lab has identified three single nucleotide polymorphisms (SNP 1, 3, and 5) within the CXCR2 gene that are associated with subclinical mastitis. However, mechanisms contributing to this change in susceptibility are unknown. As neutrophils express high levels of CXCR2 and are necessary for resolving infections, the objective of this study was to determine the association between neutrophil functional activity and CXCR2 polymorphisms. Neutrophils from 20 lactating Jersey cows were evaluated for adhesion molecule expression and chemotaxis. Baseline expression of CD11 and CD18 tended to be lower for cows with the less common SNP3 (GC) genotype when compared to the more common GG genotype. This same trend was evident

following activation with interleukin (IL)-8. Whereas stimulation with zymosan-activated sera (ZAS) resulted in significantly elevated CD11 and CD18 expression by neutrophils with GC genotypes when compared to GG genotypes ($P < 0.05$). In contrast to CD11 and CD18, baseline expression of CD62 was significantly greater in neutrophils with the GC genotype when compared to the GG genotype ($P < 0.02$). This difference was still apparent after downregulation of CD62 induced by IL-8, but not ZAS. Not only were differences observed with respect to adhesion molecule expression, neutrophil migration also was significantly reduced with the GC genotype at SNP3 when compared to the GG genotype following stimulation with ZAS ($P < 0.04$). A similar trend was observed following stimulation with IL-8 ($P = 0.17$). Neutrophils from cows with AG genotype at SNP5 performed similarly to those with genotype GC at SNP3 in all measured parameters. However, only CD62 expression was comparable between neutrophils from cows with the AG genotype at SNP1 relative to those with the GC genotype at SNP3. This work provides preliminary evidence of an association between neutrophil function and CXCR2 polymorphisms and suggests a potential mechanism for increased rates of mastitis observed in cows with specific genotypes.

Key Words: Neutrophil, Polymorphism, Mastitis

716 Restoration of normal innate immune function in immunosuppressed sheep with OmniGen-AF: a nutritional product. Y. Wang, S. B. Puntney, and N. E. Forsberg*, Department of Animal Sciences, Oregon State University, Corvallis, OR.

The goal of this research was to investigate effects of a nutritional product (OmniGen-AF) on innate immune function in immunosuppressed sheep. Sixty growing sheep were allotted to five treatments consisting of 1: Control, 2: immunosuppressed via daily injection of Dexamethasone ([Azium] 0.1 mg/kg BW/head, twice/day), 3: immunosuppressed plus OmniGen-AF (0.5% of dry matter intake), 4: immunosuppressed plus a challenge of feed-borne mold (*Aspergillus fumigatus*) and 5: immunosuppressed plus addition of moldy feed and OmniGen-AF. Sheep were provided a "dairy diet" consisting of alfalfa, corn and soybean meal for 28 days. On Day 28, blood samples were taken from six sheep on each treatment and neutrophils were purified using a Ficoll gradient. Neutrophil proteins were processed on SDS-PAGE after which concentrations of L-selectin (a neutrophil adhesion molecule which serves as a marker for innate immune function) and interleukin-1beta (IL-1B: a pro-inflammatory cytokine) were assessed using Western blot analysis. L-selectin and IL-1B concentrations were markedly reduced ($P < 0.05$) in dexamethasone-treated sheep. These observations indicate that dexamethasone effectively repressed immune function and that we had an adequate model of immunosuppression to study effects of the nutritional product. Addition of the nutritional product to Treatment 3 increased L-selectin concentration but had no effect on IL-1B. Addition of *A. fumigatus* to Treatment 4 had no effect on either L-selectin or IL-1B. However, the presence of the nutritional product (OmniGen-AF) in Treatment 5 restored ($P < 0.05$) normal concentrations of both L-selectin and IL-1B. These observations demonstrate efficacy of dexamethasone in immunosuppression and of OmniGen-AF in restoring immune function in immunosuppressed/stressed animals. The presence of a pathogen potentiated the actions of OmniGen-AF on immune function.

Key Words: Immunity, L-Selectin, Interleukin-Lbeta

717 Dietary supplementation of lipoic acid and its effect on circulating metabolic hormones and acute phase proteins of virus-challenged beef steers. T. B. Schmidt*, E. P. Berg¹, E. M. Cochran², J. J. Garcia², S. B. Kleiboeker¹, R. Larson¹, C. W. Morgan², C. D. Grager², J. A. Carroll³, D. H. Keisler¹, K. C. Olson¹, G. Rentfrow¹, and M. S. Brown², ¹University of Missouri-Columbia, ²West Texas A&M University, Canyon, TX, ³Animal Physiology Research Unit, Agricultural Research Service.

Thirty-two, virus-challenged crossbred steers were used to determine if dietary supplementation of lipoic acid (LA) modulates circulating metabolic hormones and acute phase proteins. Steers (BW=308+27kg) were randomly assigned to control (CON), 16mg of LA/kg of BW (LA16), 32 mg of LA/kg of BW (LA32), and negative control (NEG) treatments. Steers were adapted to treatment and environment for 21 d. On d 22, blood samples, nasal swabs, BW, DMI, and rectal temperature were recorded. Control, LA16, and LA32 steers received an intranasal dose of 2 mL/nostril of infectious bovine respiratory virus (Cooper stain, 1 X 10⁶-7 PFU); NEG received 2mL of saline/nostril. Blood samples,

nasal swabs, BW, DMI, and rectal temperatures were collected on 23, 25, 27, 29, 36, and 43 d. Serum samples were analyzed for haptoglobin, amyloid-A, leptin, insulin, and serum-neutralization titer levels. Prior to challenge, DMI (% of BW) was similar among treatments. Seven and 14 d post-challenge, DMI was higher ($P < 0.05$) for LA32 than CON and LA16 (1.35%-7 d; 1.88%-14 d vs. 0.95%-7 d; 1.77%-14 d, and 0.95%-7 d; 1.67%-14 d, respectively), but all treatment groups experienced BW loss during this time. However, LA32 began gaining BW by d 29 (+5.15 kg from previous BW; $P < 0.001$), while NEG, CON, and LA16 to decline (-3.45, -1.59, and -1.42 kg from previous BW, respectively). Haptoglobin concentrations were similar before the challenge (0.147, 0.133, 0.121, and 0.128 ng/mL for CON, LA16, LA32, and NEG, respectively). On d 27, LA32 had lower ($P < 0.04$) serum haptoglobin than CON (0.311 vs. 0.592 ng/mL), and lower than both CON and LA16 on d 29. Haptoglobin concentrations were at or below pre-challenge concentrations by d 36. Serum-neutralization titers for 30/32 steers were negative on d 22. However, all animals were positive for IBRV antibodies by d 43. The geometric mean titer for CON, LA16, LA32, and NEG were similar ($2^{4.29}$, $2^{5.13}$, $2^{5.13}$, and $2^{4.50}$, respectively). Supplementation of LA at 32 mg/kg of BW provides additional protection to steers facing a viral challenge associated with respiratory disease.

Key Words: Immune Response, Antioxidants, Lipoic Acid

718 Colicins E1 and N are effective against *Escherichia coli* strains responsible for post-weaning diarrhea and edema disease in swine. C. H. Stahl*, T. R. Callaway², L. M. Lincoln¹, S. M. Lonergan¹, and K. J. Genovese², ¹Department of Animal Sciences, Iowa State University, Ames, ²USDA-ARS Food and Feed Safety Research Unit, College Station, TX.

Escherichia coli infections causing post-weaning diarrhea and edema disease are one of the most prevalent disease problems in swine in the U.S. More than 43% of the large swine facilities in the U.S. reported *E. coli* infections among weaned pigs in 2000 and in an attempt to prevent the spread of these infections more than 78% of these facilities reported using prophylactic antibiotic treatments. The strains considered primarily responsible for these infections, F4 (K88) and F18, are not well controlled by traditional prophylactic antibiotic treatments, and with worldwide concern over the use of prophylactic antibiotics in animal agriculture, the development of alternatives to conventional antibiotics is urgently needed to protect swine from these *E. coli* infections. Colicins have been shown effective against other pathogenic *E. coli* strains, but their efficacy against the *E. coli* strains responsible for post-weaning diarrhea and edema disease has not been examined. The efficacy of two pore-forming colicins, E1 and N, against *E. coli* F4 (K88) and F18 were determined quantitatively in vitro. Colicin E1 and N were expressed by native producers and purified by ion exchange chromatography. The purified colicins were quantified and used in growth inhibition dose-response studies against *E. coli* F4 (K88) and F18. Both colicins were effective against both strains of *E. coli*, however their efficacy varied greatly. Colicin E1 was more effective against F18 than F4 (K88) ($P < .01$), requiring approximately 1 $\mu\text{g/mL}$ of culture to completely inhibit the growth of F18 and an approximately 50 $\mu\text{g/mL}$ to inhibit the growth of F4 (K88). Colicin N was less effective than Colicin E1 against *E. coli* F18 ($P < .01$), requiring fifty fold higher concentrations in order to achieve the same level of growth inhibition, but more effective against the F4 (K88) strain ($P < .01$), requiring only half the concentration of Colicin E1 to obtain the same growth inhibition. These antimicrobial peptides may provide an effective and environmentally sound method to prevent post-weaning diarrhea and edema disease in swine.

Key Words: Colicin, Antibiotic Alternatives, Post-Weaning Diarrhea

719 Infectious dose of young pigs experimentally inoculated with PRRS virus by oral and intranasal routes. J. R. Hermann*, M. Kaiser¹, M. Roof², K. Burkhardt², and J. J. Zimmerman¹, ¹Iowa State University, Ames, IA, ²Boehringer Ingelheim, Ames, IA.

Prevention and control of PRRS virus requires an understanding of transmission in the field. Current reports in the literature suggest that swine are susceptible to PRRS virus by several exposure routes, including intranasal, intramuscular, and oral. The infectious dose by either intranasal or intramuscular routes is known to be very low. Infection of swine via oral exposure has been reported, but the minimum infectious dose has not been estimated. Thus, data on the specific exposure dose

necessary for infection is needed to assess the likelihood of transmission by oral exposure in the field. This study was designed to estimate the probability that a specific oral dose of PRRS virus would result in infection. The experiment was conducted as a randomized block design in which individually housed 19 - 24 day old pigs were orally exposed to a specific dose (titer) of PRRS virus (2 to 7 logs TCID₅₀). Each replicate consisted of 10 animals: 4 treatment levels of PRRS virus (run in duplicate), plus positive and negative control animals. To test a volume effect, treatment doses were administered in either 10 ml or 100 ml volumes. Animals were bled on days -7, 0, 7, 14, 21 and serum samples tested for evidence of PRRS virus infection by virological and serological assays to determine whether exposure resulted in infection. The pig was considered the experimental unit. The primary outcome for this study is binary, i.e., pigs become infected or not. The resulting probabilities at each dose were used to construct and infectious dose curve using a single hit model based formula. The estimated infectious dose₅₀ (ID₅₀) of young healthy pigs is 10⁵ TCID₅₀. However an oral treatment dose of 10³ TCID₅₀ were sufficient to cause infection in young swine. No differences existed between antibody levels by route or dose of exposure.

Key Words: PRRS Virus, Swine, Oral

Beef Species: Enhancing Energetic Efficiency

721 Growing program effects on efficiency of energy use by feedlot cattle. C. R. Krehbiel*, M. P. McCurdy, and G. W. Horn, *Oklahoma State University, Stillwater.*

Maintenance energy requirements can account for more than half of the ME intake by beef cattle. It is generally accepted that ADG and efficiency during finishing are directly related to plane of nutrition and energy density of the diet during the growing phase. Steers that are fed for high ADG during the growing phase accrete a greater percentage of their BW gain as fat than restricted steers, and contain more fat upon feedlot entry. Restricted steers have greater protein content as a percentage of BW, and are generally considered to have a lower NE_g requirement. Cattle that have had greater rates of BW gain during the growing phase are generally assumed to be less efficient and have decreased gains during the finishing phase. This concept is consistent with the 1996 Beef Cattle NRC Level 1 Model, which shows a negative correlation between predicted ME allowable ADG and initial body fat content. In contrast, recent literature has reported that cattle subjected to greater ADG during the growing phase might not always experience lower ADG or gain efficiency during the finishing phase. Reasons for discrepancies are not fully understood. Changes in visceral organ mass might change the amount of nutrients available for growth. Several authors have observed that when ME intake was restricted, mass of the gastrointestinal tract (GIT) was similar or decreased compared with animals fed above maintenance or ad libitum. In contrast, ruminants restricted by energy density of the diet have greater GIT mass as a percentage of BW. The GIT appears to respond to physical form of the diet and fiber content, which could increase NE_m requirements during finishing. Investigation into gain and efficiency of feedlot cattle must provide a complete picture of nutritional management through all production segments due to the number of potential factors that may determine performance in the feedlot. A comprehensive understanding of animal biology will allow us to enhance efficiency of beef production systems, and improve end-product quality.

Key Words: Cattle, Energetic Efficiency, Gastrointestinal Tract

720 A deterministic risk assessment of macrolide use in swine. A. G Mathew*¹, H. S. Hurd², S. Doores³, D. Hayes⁴, J. Maurer⁵, P. Silley⁶, R. N. Jones⁷, and R. Singer⁸, ¹University of Tennessee, Knoxville, ²Hurd-Health Consulting, Roland, IA, ³Pennsylvania State University, University Park, ⁴Iowa State University, Ames, ⁵University of Georgia, Athens, ⁶MB Consult Limited, Bingley, West Yorkshire, UK, ⁷The JONES Group/JMI Laboratories, North Liberty, IA, ⁸University of Minnesota, St. Paul.

To quantify risks stemming from antibiotic-resistant bacteria as a possible consequence of macrolide antibiotic use in swine, a farm-to-patient deterministic risk assessment was formulated using extensive scientific and government numerical data. The model was developed based on the US FDA Center for Veterinary Medicine Guidance Document 152, which advises veterinary drug sponsors of one potential process for conducting a qualitative risk assessment of drug use in food animals. The scope of modeling included all label claim uses of both antibiotics in U.S. swine production, including therapeutic, disease prevention, disease control, and growth promotion, as indicated by CVM-approved label claims for swine. The defined hazard was illness caused by a food-borne bacterium with a resistance genetic element(s), attributed to pork, and treated with a human-use macrolide drug. Risk was defined as the probability of this hazard combined with the consequence of treatment failure due to resistant *Campylobacter spp.* or *Enterococcus faecium*. A binomial fault tree model was applied to estimate this annual risk for the general US population. This risk assessment demonstrated that use of tylosin and tilmicosin in swine present a very low risk, with an approximate annual probability of less than 1 in 53 million *Campylobacter spp.*-derived and less than 1 in 27 billion *Enterococcus faecium*-derived risks.

Key Words: Macrolide, Antibiotic Resistance, Risk Assessment

722 Nutrition *in utero* and pre-weaning has long-term consequences for growth and size of Piedmontese- and Wagyu-sired steers. P. L. Greenwood*^{1,2}, H. Hearnshaw^{1,3}, L. M. Cafe^{1,3}, D. W. Hennessy^{1,3}, and G. S. Harper^{1,4}, ¹CRC for Cattle and Beef Quality, Armidale, NSW, Australia, ²NSW Agriculture, Armidale, NSW, Australia, ³NSW Agriculture, Grafton, NSW, Australia, ⁴CSIRO Livestock Industries, St. Lucia, QLD, Australia.

Piedmontese (PxH) and Wagyu (WxH) x Hereford steers were selected for divergence in birth weight (PxH, Low mean±SEM 31.4±0.8 and High 42.1±0.9 kg; WxH, Low 27.4±0.7 and High 36.7±0.6 kg) and pre-weaning growth following high (irrigated improved temperate pastures) or low (sub-tropical native pastures) nutrition during pregnancy and either high or low nutrition from birth to weaning. Steers were weaned at 7 months of age and grown on improved temperate pastures, with supplementation as required to maintain growth, to 26 months of age when they entered a feedlot for 105 days prior to slaughter. Steers from dams nutritionally restricted during gestation and/or steers nutritionally restricted from birth to weaning had lower live and carcass weights compared to their high birth weight plus high pre-weaning nutrition (HH) counterparts at 30 months of age, this being most evident in the low birth weight plus low pre-weaning nutrition (LL) steers. These results support the notion that nutritional restriction early in life limits capacity to compensate when adequate nutriment is restored. However, retail yield on a carcass weight-specific basis was greater in the LL steers compared to their HH counterparts. This finding, and the lack of nutritional effects on indices of carcass fatness beyond those attributable to differences in body weight of these animals, does not support the notion that increased fatness later in life is a consequence of nutritional restriction early in life. We conclude that nutrition early in life has long-term consequences for growth and size of steers at any given age to 30 months.

Table. Performance of Piedmontese (PxH) and Wagyu (WxH) x Hereford steers with divergent birth weight and pre-weaning growth as a result of high or low nutrition *in utero* and pre-weaning (HH, LH, HL, LL).

	PxH	WxH	LSD	HH	HL	LH	LL	LSD	Effects
Number of animals	40	39	-	20	19	20	20	-	-
Pre-weaning ADG, g	735	729	46	950	582	864	533	63	N
Weaning live wt, kg	195	191	12	243	161	222	145	18	N
Weaning to feedlot entry ADG, g	619	601	23	602	629	580	629	32	G†,N
Feedlot entry live wt, kg	527	512	15	562	499	529	487	22	G†,N,GxN†
Feedlot ADG, g	1420	1295	75	1388	1375	1339	1329	107	G,GxN
Weaning to feedlot exit ADG, g	713	677	24	689	715	664	712	34	G,N
Live wt at feedlot exit, kg	673	645	20	705	641	667	623	28	G,N
Hot carcass wt, kg	385	362	12	400	363	380	350	17	G,N
Dress, % hot carcass wt	57.2	56.0	0.5	56.7	56.6	56.9	56.1	0.8	G
Carcass LMA, cm ²	87.8	82.5	3.5	83.9	85.0	87.8	84.0	4.8	G,W
Carcass fat, mm	15.8	20.8	2.9	19.4	17.4	19.5	17.0	4.1	G,W
USDA marbling score	386	536	32	450	460	455	479	45	G
Retail yield, % cold side weight	69.0	64.2	0.8	65.8	66.6	66.5	67.5	1.2	G,N

Treatment group values are unadjusted means. Effects ($P < 0.05$, † $P < 0.10$) as determined by ANOVA where G = genotype and N = nutrition, or ANCOVA for carcass composition-related variables, where W = cold side wt covariate.

Key Words: Cattle, Nutrition, Growth

723 Effects of limit feeding on net nutrient flux and oxygen consumption by the portal-drained viscera. M. P. McCurdy*, M. J. Hersom, C. R. Krehbiel, and G. W. Horn, *Oklahoma State University, Stillwater.*

Ten steers (average initial BW = 430 ± 42 kg) were used in a randomized complete block design over two observation periods. Steers were blocked by previous treatment (high or low BW gain while grazing winter wheat pasture) and allotted to two treatment groups in a switch-back design. The purpose of the experiment was to determine the effects of ad libitum feeding versus limit feeding on diet digestibility, visceral organ mass, blood flow, blood gas measurements, oxygen consumption, and net flux of metabolites across the portal-drained viscera (PDV) of finishing beef steers fed a high-concentrate diet. Treatments were ad libitum feeding of the diet (CON) or feeding at 90% of ad libitum (LF). Limit-fed steers consumed 86.5% and 87.8% of the actual DMI of CON steers during period 1 and 2, respectively. Limit-feeding increased DM ($P < 0.05$) and OM ($P < 0.05$) digestibility of the diet by 3.9% and 3.8%, respectively compared with CON steers, whereas N digestibility did not differ ($P = 0.21$) among treatments. The increase in digestibility resulted in similar (5.53 vs 5.22 ± 0.48 kg/d; $P = 0.46$) digestible OM intake among treatments. Net flux of α -amino N and urea N were not different among treatments. Concentrations of glucose in arterial and portal blood tended ($P = 0.06$) to be greater for CON steers; however, net portal removal of glucose tended ($P = 0.07$) to be greater in CON steers suggesting greater glucose utilization by the PDV. No significant differences were observed in blood gas measurements, and oxygen consumption by the PDV did not differ among treatments (-475 vs -437 mmol/h for CON and LF, respectively). After 34 d of limit-feeding, visceral organ mass did not differ among treatment groups. The increase in OM digestibility by LF steers suggests nutrient availability was similar among treatments. Combined with lower utilization of glucose and similar oxygen consumption by the PDV, our data suggests more efficient utilization of nutrients by limit-fed steers.

724 Effect of time of feeding a limit-fed high grain diet during winter months on growing feedlot steers. S. M. Holt*, R. H. Pritchard, and J. A. Clapper, *South Dakota State University, Brookings.*

The effect of feeding time on physiological status and performance of steers in the winter was investigated during a 56-d feedlot growing study. Steers were limit-fed a high moisture ear corn diet (2.04 Mcal/kg NE_m, 1.39 Mcal/kg NE_g) at 0900h (AM) or 1500h (PM) to allow for gain of 1.40 kg/d. Calculations of NE_g intake were derived using NRC equations and tabular values for dietary ingredients. Climatic data were collected

hourly throughout the study via an automated weather station located at the feedlot. Tympanic temperatures (TT) were collected every 15 minutes (3 steers/treatment) for 6d (d45 to 50) during the final 14 d period. Serum free T₃ and T₄ concentrations were determined from blood samples (18 steers/treatment) collected on d44 and d51. Ambient temperature (T_a) during the 56 d growing study ranged from -21.4 to 13.2° C with a mean of -5.7° C. During the 6 d TT collection period, mean T_a was -2.0° C and ranged from -19.2 to 0.4° C. Initial BW was 298 ± 5 kg. Body weight after 56d growing period (393 kg vs 401 kg), ADG (1.70 vs 1.84 kg) and gain efficiency (231 vs 250 g/kg) differed ($P < 0.05$) between AM and PM groups, respectively. Serum free T₃ and T₄ levels were similar for both treatment groups. Mean TT were similar (39.4 vs 38.9° C; $P > 0.10$) between AM and PM groups, respectively. No changes in diurnal TT patterns were observed. Minimum TT during the 6d collection period tended to be higher for the AM compared to the PM group (38.9 vs 38.4° C; $P = 0.09$), respectively. Maximum TT were higher for AM than PM (40.0 vs 39.4° C; $P < 0.05$). Based upon performance, maintenance energy expenditure was increased 25.1% for the AM group ($P < 0.05$). T₃ and T₄ levels were unable to explain this difference. It is possible that when offering feed in the morning compared to the afternoon, basal metabolic rate has to be increased to maintain body temperature. The TT data suggest animals may overestimate energy requirement and increase body temperature above normal levels, resulting in reduced performance.

Key Words: Tympanic Temperature, Steers, Feedlot

725 Residual feed intake: an alternative measure of feed efficiency for beef cattle. Gordon E. Carstens*¹ and M. S. Kerley², ¹Texas A&M University, College Station, ²University of Missouri, Columbia.

Feed inputs represent more than 60% of the cost of producing beef, and manure outputs are the primary contributor to the industry's adverse effect on the environment. Thus, feed efficiency is an important trait to consider developing selection programs to identify cattle that are more economically and environmentally sustainable to produce. Considerable genetic variation is known to exist in feed efficiency, but the expense of measuring feed intake has precluded the implementation of selection programs that target this trait. Moreover, the traditional measure of feed efficiency (feed:gain ratio; F:G) is known to be inversely related to growth and mature size, such that selection for improved F:G leads to increases in cow size. Recent developments provide opportunities to improve the genetic merit of cattle for feed efficiency: (1) emerging commercialization of new technologies to more cost effectively measure feed intake in cattle and (2) discovery of an alternative measure of feed efficiency (residual feed intake; RFI) that will facilitate selection of more efficient cattle with minimal effects on growth traits or cow mature size. RFI is calculated as the difference between an animal's actual feed intake and the feed an animal is expected to consume based on its weight and growth rate—cattle that eat less than expected for their weight and growth will have a negative RFI or improved net feed efficiency. RFI has been shown to be moderately heritable and genetically independent of growth and mature size in cattle. Multidisciplinary research is needed to determine the biological basis for variation in RFI, and to examine the effects of selection for RFI on reproductive efficiency, carcass composition and meat quality. Discovery of management practices, genetic markers, and physiological (e.g., IGF-1) or physical (e.g., exit velocity, feeding behavior) traits that are predictive of RFI would be useful to more accurately and cost-effectively identify animals with superior genetics for RFI. Increasing genetic merit for RFI has potential to reduce production costs, mitigate environmental effects of producing beef and increase the competitive position of the beef industry.

Key Words: Residual Feed Intake, Efficiency, Beef Cattle

726 Correlations among ultrasound carcass estimates, growth performance measures, and residual feed intake in Angus steers. J. I. Szasz*, C. W. Hunt, S. D. Baker, T. Klein, P. S. Kuber, B. Glaze, D. Falk, R. Richard, J. Miller, R. A. Battaglia, and R. A. Hill, *University of Idaho, Moscow.*

Residual feed intake (RFI) has received increasing attention as an alternative measure of gain efficiency (GEF; gain per DMI) in beef cattle. The objectives of the current study were to evaluate RFI in purebred Angus steers using novel linear regression equations and to define correlation coefficients between attributes of growth, ultrasound measures

and RFI. Steers (n = 54; mean BW 341 kg) were individually fed (electronic feeding gates) a forage-based growing diet for 70 d. Daily DMI, biweekly BW, initial (d 0) and final (d 70) ultrasound estimates of 12th rib fat thickness (BF), longissimus muscle area (REA), and intramuscular fat percent (IM) were determined. In addition to RFI computations reported in previous literature ($DMI = \beta_1 \cdot ADG + \beta_2 \cdot \text{metabolic BW}$), DMI was regressed against ADG, metabolic BW (MBW), and ultrasound measurements using stepwise regression techniques. Ultrasound measurements were included as well as their MBW-adjusted counterparts. The adjusted model included effects due to ADG, MBW, and final BF ($R^2 = 0.71$; $RMSE = 0.51$) resulting in a minor improvement over the original equation ($R^2 = 0.68$; $RMSE = 0.53$). Measures of BW, ADG, final REA, and IM were not ($P > 0.90$) correlated with RFI, whereas, RFI was correlated ($P < 0.05$) with DMI ($r = 0.56$), GEF ($r = -0.44$), and final BF ($r = 0.28$). In addition, GEF was correlated ($P < 0.01$) with initial BW ($r = -0.46$), ADG ($r = 0.65$), DMI ($r = -0.40$), and initial REA ($r = -0.64$). Range in RFI was -1.12 to +1.52 kg DMI, and both models indicated that low RFI steers (RFI < 0.5 SD below the mean) had lesser ($P < 0.02$) DMI than high RFI steers (RFI > 0.5 SD above the mean) and that high RFI steers had lesser ($P < 0.01$) GEF than low RFI steers. When the conventional model was used, final BF was lowest ($P < 0.001$) for low RFI steers. These data are consistent with previous studies where low RFI steers appear to be slightly leaner.

Key Words: Beef Cattle, Gain Efficiency

727 Relationship of feeding behavior to feed efficiency in crossbred Angus steers. J. W. Golden* and M. S. Kerley, *University of Missouri-Columbia*.

A study was conducted to determine the relationship between feed efficiency and feeding behavior of feedlot steers. The hypothesis was that high and low efficiency steers would not differ in feeding behavior. Crossbred Angus steers (n = 80) were fed ad libitum and individual feed intakes were recorded by the GrowSafe® feed intake system. Recorded intakes were used to calculate residual feed intake (RFI), a measure of efficiency. RFI values were calculated three consecutive months, and animals were identified as efficient (n = 6) or inefficient (n = 6). Average RFI values for the efficient (-1.564) and inefficient (1.657) groups differed ($P < 0.01$). Data from these 12 animals were analyzed. Starting and ending weights did not differ ($P > 0.10$) between groups. Average daily intake (7.94 kg vs. 11.70 kg) and average eating bouts per day (10.99 vs. 18.15 visits) differed ($P < 0.01$), with efficient animals consuming less feed and eating fewer times per day. Grams eaten/minute (97.9 vs. 94.7) did not differ ($P > 0.10$) between high and low efficiency groups. Average daily gain for the efficient and inefficient animals (1.40 vs. 1.50 kg/day) did not differ ($P > 0.10$). The feed to gain ratio differed ($P < 0.01$) between groups. Time of day eating bouts occurred was divided into eight periods (1,2,3,4,5,6,7 and 8). Each period was 3 hours in length with period 1 occurring from 12-3a.m., and each remaining period following consecutively in 3 hour time blocks. The amount of feed consumed differed ($P < 0.05$) in periods 3,4,5,6 and 7 when comparing groups. Periods 4,5 and 6 represented the periods when most feed consumption occurred. In the high efficiency group the amount consumed between periods 4,5 and 6 did not differ ($P > 0.10$). However, in the low efficiency group the amount of feed consumed in periods 4,5 and 6 differed ($P < 0.05$). The differences in consumption between periods in the low efficiency group and the lack of difference in the high efficiency groups cannot be fully explained. Further study is warranted to determine if a link exists between eating patterns and efficiency status of an animal.

Key Words: RFI, Eating Behavior

728 The effect of mitochondrial uncoupling proteins 2 and 3 on feed efficiency in crossbred angus steers. W. H. Kolath*, M. S. Kerley, and J. W. Golden, *University of Missouri-Columbia*.

The objective of this study was to determine if a relationship exists between uncoupling proteins 2 and 3 (UCP 2&3) and feed efficiency. Inefficient animals would hypothetically be expected to have greater expression of UCPs than efficient animals. Crossbred Angus steers (n=80), fed ad libitum, had their individual feed intake recorded via the GrowSafe® feed intake system over a three-month period. Intakes were used to calculate residual feed intake (RFI), a measure of efficiency. Tissue samples were taken from the *longissimus lumborum* muscle from

both the most (RFI -1.564; n = 6) and least (RFI 1.657; n = 6) efficient animals. Tissue samples were immediately frozen in liquid nitrogen and stored at -80°C until further analysis. Total RNA was extracted and reverse transcribed to cDNA. Uncoupling protein 2&3 cDNA was measured by quantitative real-time polymerase chain reaction. Protein was also extracted from the tissue samples and fractionated on 10% SDS-Page gels, blotted to PVDF membranes and probed with antibodies against UCP 2&3. No difference in either cDNA expression or protein expression was observed. Mitochondrial uncoupling proteins 2 and 3 are therefore believed to be unrelated to feed efficiency.

Key Words: Mitochondria, Uncoupling Protein, Feed Efficiency

729 Variation in energy expenditures between growing steers with divergent residual feed intakes. Monte B White*, Gordon E Carstens, Casey M Theis, Michael W Kurz, Ching-Yi Chen, Lisa J Slay, and Tom H Welsh Jr., *Texas A&M University, College Station*.

Residual feed intake (RFI) is a measure of feed efficiency that quantifies variation in feed intake beyond that needed for maintenance and growth requirements. For this study, steers with the lowest (low; n = 9) and highest (high; n = 9) RFI were selected from 169 Braunvieh-sired crossbred steers that were individually fed a pelleted roughage-based diet (calculated metabolizable energy; ME = 2.2 Mcal/kg DM) for 77 d using Calan feeders. RFI was calculated as the difference in actual DMI and DMI predicted from the regression of DMI on mid-test BW^{.75} and ADG. Objectives of this study were to determine if variation in energy expenditures contributed to differences in feed efficiency between low and high RFI steers. Following the 77-d RFI period, steers were fed the same diet while being halter broken and adapted to respiration chambers. Steers were fed at 1.1X maintenance for 4 d and heat production (MHP) measured for two consecutive 22-h periods using indirect calorimetry. HP was measured on d 3 and 4 of fasting (FHP) and metabolizable energy for maintenance (ME_m) calculated using linear regression of ME intake on retained energy. Heart rate (HR) and motion activity were measured concurrently with HP. During the 77-d RFI period, low RFI steers had lower ($P < .001$) RFI (-1.7 vs 1.6 ± .17 kg/d), DMI (7.7 vs 10.2 ± .42 kg/d) and feed:gain ratio (F:G; 7.2 vs 10.6 ± .60), but similar final BW (331.5 ± 10.2 kg) and ADG (1.1 ± .07 kg/d). However, during the 112-d calorimetry phase, there were less differences in DMI (8.4 vs 9.7 ± .38 kg/d; $P = .02$) and F:G (9.7 vs 10.8 ± .40; $P = .07$) between low and high RFI steers. No differences were found in FHP (98.5 vs 102.1 ± 3.1 kcal/kg^{.75}/d) or ME_m (148.4 vs 151.0 ± 4.1 kcal/kg^{.75}/d) between low and high RFI steers. Likewise, no differences were found in HR, respiratory quotients or motion activities during FHP and MHP measurements. The lack of differences in FHP and ME_m between divergent RFI steers may have been the result of alterations in feeding behavior or activity imposed by adapting steers to calorimetry chambers.

Key Words: Residual feed intake, energy expenditure, cattle

730 Effects of Revalor®-200 vs. Finaplix®-H in single and reimplant strategies for yearling heifers. C. D. Reinhardt¹, W. T. Nichols*¹, J. P. Hutcheson¹, S. Swingle², and K. Karr², ¹*Intervet, Inc., Millsboro, DE*, ²*Cactus Research, Ltd, Amarillo, TX*.

One thousand eight hundred eighty-five English×continental yearling heifers (309 kg) were used in a randomized complete block study to evaluate the effects of Finaplix-H and Revalor-200 in single or reimplant strategies. Heifers were blocked by arrival date and assigned to one of four treatments: 1)Finaplix-H (200 mg trenbolone acetate (TBA)) on d0 (FH); 2)Revalor-200 (20 mg estradiol 17β (E₂) + 200 mg TBA) on d0 (R200); 3)Revalor-IH (8 mg E₂ + 80 mg TBA) on d0 and Finaplix-H on d60 (IHFH); 4)Revalor-IH on d0 and Revalor-200 on d60 (IH200). There were 5 pens per treatment with an average of 94 head per pen. Heifers were harvested after 137 days on feed. The R200 heifers had higher ADG ($P = 0.08$) and tended to have improved feed:gain ($P = 0.11$) on a carcass-adjusted basis than the FH heifers. The FH heifers had higher marbling score and higher percent Prime+Choice than any other treatment ($P < 0.01$), but they also had higher yield grade, calculated empty body fat (EBF), and lighter predicted live weight at 28% EBF than either the R200 or IH200 heifers ($P < 0.05$), indicating that they finished sooner and lighter than the R200 and IH200 heifers. The IH200 heifers had lower DMI than any other treatment ($P < 0.05$), characterized by a

marked and sustained reduction in DMI following the reimplant event. Due to the lower DMI, the IH200 heifers had lighter final weight and lower ADG on a live basis ($P < .01$) than the IHFH heifers, but these differences were reduced on a carcass-adjusted basis. The IH200 heifers had significantly improved feed conversion compared to FH and R200 ($P = 0.01$) and tended to have better feed conversion than IHFH ($P = 0.14$) on a carcass-adjusted basis. The IH200 heifers had significantly higher dressing percent, less rib fat, larger ribeye area, lower average yield grade, greater percentage yield grade 1 & 2, lower EBF, and heavier predicted weight at 28% EBF than any other treatment ($P < 0.01$). These data indicate that Revalor-200 may improve performance and EBF-adjusted final weight compared to Finaplix-H in either single or reimplant strategies utilized in yearling heifers.

Carcass-adjusted¹ Performance and Carcass data

Item	FH	R200	IHFH	IH200
DMI, kg	7.97 ^a	7.99 ^a	7.92 ^a	7.68 ^b
ADG, kg	1.39 ^a	1.42 ^b	1.44 ^b	1.41 ^{ab}
F:G	5.73 ^a	5.62 ^{ab}	5.52 ^{bc}	5.45 ^c
Pr+Ch,%	55.1 ^a	37.3 ^b	42.1 ^b	36.4 ^b
YG	2.6 ^a	2.4 ^b	2.6 ^{ab}	2.1 ^c
EBF, %	28.4 ^a	27.6 ^b	28.1 ^a	26.9 ^c
AFBW ² , kg	505 ^a	518 ^b	516 ^b	532 ^c

¹Adjusted for common dressing percent.

²Final live weight adjusted to 28% EBF; ^{a,b,c}differ ($P < .05$)

Key Words: Anabolic Implants, Feedlot, Heifer

Breeding and Genetics: Dairy Genetic Evaluation

731 International genetic evaluation of longevity traits. J. H. Jakobsen* and U. Emanuelson, *Interbull Centre, Uppsala, Sweden.*

The first test run for international genetic evaluation of longevity traits took place in March 2004 and was performed for the Holstein breed. The test run is an outcome of preliminary research studies, which showed feasibility of international genetic evaluation for longevity traits. The 14 countries participating in the research studies defined longevity either as risk of involuntary culling, length of productive life, or survived as a 0-1 trait. Traits were analyzed nationally with linear mixed models and survival analysis. International genetic evaluations were performed using Multitrait Across Country Evaluation (MACE), and correlations between countries ranged in the research study from zero to 0.92, and were on average 0.59. Two different traits have been defined within the longevity trait group. These are longevity as a direct trait and longevity as a trait combined with indicator traits. Combined longevity is a complex trait in the sense that the choice of indicator traits is very variable across countries. Also, procedures to calculate weighting factors for the deregressed national combined proofs, as input to MACE, is unresolved. The first official test run was therefore performed for direct longevity only, but research is currently going on to investigate such unresolved issues for combined longevity. Research is also ongoing to investigate feasibility of international evaluation for longevity for other breeds than Holsteins. The presentation will focus on correlations between countries and selection differentials from the March test run for direct longevity.

Key Words: MACE, longevity

732 Correlated traits used for indirect prediction of productive life in Holsteins. S. Tsuruta*¹, I. Misztal¹, and T. J. Lawlor², ¹University of Georgia, Athens, ²Holstein Association USA Inc., Brattleboro, VT.

The purpose of this study was to update formulas used for indirect prediction of productive life from correlated traits. Productive life was defined as days in milk at age 84 mo within the limit of 305 DIM for each lactation. Genetic parameters for 25 traits (productive life, milk, fat, protein, somatic cell score, days open, 18 linear type, and final score) were estimated with a multiple-trait sire model via Gibbs sampling. The data contained 392,800 records for Holstein cows born from 1995 to 1997. The model included registration status, herd-year, age group, month of calving and stage of lactation as fixed effects, and random sire genetic effects and residual effects. Heritability for productive life was estimated as 0.09. Genetic correlations of productive life with milk, fat, protein, somatic cell score, days open and final score were 0.11, 0.11, 0.12, 0.32, 0.62 and 0.13, respectively. Stronger correlations with linear type traits were 0.37 for udder depth, 0.29 for body depth, 0.27 for fore attachment, and 0.25 for dairy form. Using all of the 24 traits, productive life can be predicted with the maximum reliability of 0.69. Using five traits (in order of declining importance: days open, udder depth, milk, stature and somatic cell score), the maximum reliability was 0.61. Compared to currently used correlations for indirect prediction, many correlations changed sign, indicating changes in definition of productive life and that many conformation traits have intermediate optima. Days open became the most correlated trait with productive life.

Key Words: Genetic correlation, Productive life, Holstein

733 Analysis of the relationship between type traits and functional survival in Canadian Jersey cows. A. Sewalem*^{1,2}, G. Kistemaker², and B. Van Doormaal², ¹Agriculture and Agri-Food Canada, ²Canadian Dairy Network.

The aim of this study was to explore the impact of type traits on the functional survival of Canadian Jersey cows using a Weibull proportional hazard model using the Survival Kit. The data set consisted of 49,791 cows from 900 herds calving from 1985 to 2003. Functional survival was defined as the number of days from the first calving to culling or death or censoring. Type information consisted of phenotypic type scores of 8 composite traits and 20 linear descriptive traits. The statistical model included the effects of stage of lactation, season of production, the annual change in herd size, type of milk recording supervision, age at first calving, effects of milk, fat and protein yields calculated within herd-year-parity deviations, herd-year-season of calving, one type trait and the sire. Analysis was done one at a time for each of 30 type traits. The relative culling rate was calculated for animals in each class after accounting for the above-mentioned effects. Among the composite type traits with the greatest contribution to the likelihood function were final score, mammary system, fore udder, rear udder and dairy character, all having a strong relationship with functional survival. Cows with low scores (i.e., classified as Poor) for these traits had higher risk of culling ranging 2 to 5 times compared to higher scores (i.e., classified as Excellent). Linear type traits with the greatest contribution to the likelihood function were style, fore attachment, udder texture and udder depth. Rump angle and set of rear legs had no strong relationship with functional survival compared to other linear type traits.

Key Words: Functional Survival, Jersey, Type Trait

734 Potential of three-stage selection strategies for enhancing the efficiency of progeny testing programs in US dairy cattle. K. Weigel* and N. Zwald, *Department of Dairy Science, University of Wisconsin, Madison.*

The focus of dairy cattle improvement programs has evolved from single-trait selection for milk yield to multiple-trait selection for production, type, and various measures of health, fertility, longevity, and calving performance. In the US, national genetic evaluations for productive life (PL), somatic cell score (SCS), daughter calving ease (DCE), and daughter pregnancy rate (DPR) have all been implemented in the past decade. However, the reliabilities (REL) of predicted transmitting abilities (PTA) for these "functional" traits are low for many important bulls, because heritability parameters for these traits are =10% and because progeny groups for first-crop artificial insemination (AI) sires in the US typically contain only 60-80 daughters. This can lead to errors in selection of sires of sons. For example, 18 of the top 50 Holstein bulls for Lifetime Net Merit (LNM) in February 2002 ranked below the 80th percentile for LNM in February 2004, long before their sons had completed progeny testing. Our objective was to evaluate the potential for a "third stage" of selection among elite AI sires at 84-90 mo of age (in addition to pedigree selection at 0-6 mo of age and first-crop progeny selection at 48-54 mo of age) resulting from the distribution of additional semen for the top 50% of "sires in waiting" (based on updated parent averages) at 30-36 mo of age. Because service sire calving ease data are typically available

by 30 mo of age, this semen could be used safely on both milking cows and virgin heifers. Based on our analysis, it appears that additional semen collected from sires in waiting could replace sales of semen from the bottom 50% of actively marketed proven sires with no adverse effects on genetic progress. More importantly, distribution of additional semen from potential future sires of sons at 30-33 mo of age would provide REL = 80% for traits such as PL, SCS, DCE, and DPR and REL = 90% by the time AI stud managers make final semen collection decisions on their yearling sons.

Key Words: Progeny Testing, Functional Traits

735 Genetic base and trait definition update. P. M. VanRaden*, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Base changes provide an opportunity to revise trait definitions and to review genetic progress. Genetic bases were updated previously in the United States in 1965, 1974, 1984, 1989, 1995, and 2000, and the next is scheduled for February 2005. Interbull survey forms indicate that 18 of 25 countries plan to update their genetic bases for yield traits on this recommended 5-yr schedule; the other 7 countries update every year or at each evaluation. Countries may each define their own scales of expression and bases, but international marketing would be simpler with some uniformity and harmonization. For Interbull evaluations of udder health (UH), 9 of 19 countries currently reverse their scales so that lower somatic cell scores (SCS) result in higher evaluations. Six countries in northern Europe report relative breeding values with a mean of 100 but different multipliers (4, 5, 7, 10, or 12) of genetic standard deviation (SD). The four countries that report clinical mastitis evaluations all reverse their scales. The United States could report predicted transmitting abilities (PTA) for UH using the formula $PTA_{UH} = -5(PTA_{SCS} - \text{breed mean})$. This formula converts to the reversed, standardized PTA scale used by France and Spain with mean of 0 (instead of breed mean) and SD of 1. One unit of PTA UH would decrease somatic cell count by 13%. The range for PTA UH is similar to those for conformation, productive life, and daughter pregnancy rate PTA. If many traits are evaluated, sub-indexes may provide the public with fewer numbers that are easier to use. For most traits, genetic progress during the last 5 yr was similar to progress during the previous 5 yr. The genetic variance base was last updated in 1995. The SD of PTA for yield traits will increase by about 10% as a result. At the last base change, net merit units were revised from a per-lactation to lifetime-profit basis. Breed-association, USDA, and foreign selection indexes and genetic evaluations might be easier to use if further revised to obtain similar units, directions, and bases.

Key Words: Genetic Base, Udder Health, Scales

736 International evaluation of Milking Shorthorn-type dairy cattle for production traits. R. A. Barrett*¹, F. Miglior², J. Jamrozik¹, and G. Jansen¹, ¹*CGIL, Department of Animal & Poultry Science, University of Guelph, ON, Canada*, ²*Agriculture & Agri-Food Canada, Guelph, ON, Canada.*

Pedigree information and test-day records for the first three parities from Canada, Australia, New Zealand, the United Kingdom, and the United States were received and edited. Number of milk yield test-day records used for each country was 607,655 for Australia, 17,802 for Canada, 155,134 for the United Kingdom, 61,439 for New Zealand, and 176,498 for the United States. Single-country, single trait parameter estimation was done for each data set using a random regression test-day model using Gibbs sampling and Legendre polynomials of order four. Fixed effects in the model included herd-test day class and age at calving-parity-season of calving class. Average daily heritabilities in first lactation ranged between 0.332 and 0.474 for milk and between 0.370 and 0.445 for protein across the five countries. Correlations between lactations were higher for the United States and Canada for both milk and protein, with the more grazing-dependant countries having lower between lactation correlations. Common sires and daughters of common sires were identified, and these daughters were used to select a subset of herds for multiple-country, single trait parameter estimation. Variance component estimation of the multiple country data is underway using a random regression test day animal model using Gibbs sampling and Legendre polynomials of order 4.

Key Words: Dairy cattle, International evaluation, Milking Shorthorn

737 Accounting for differences in rate of maturity in yield evaluations. G. R. Wiggins* and P. M. VanRaden, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Genetic evaluations that include repeated records usually assume genetic merit is the same across all lactations. Repeatability models are simpler to set up and solve than models with separate genetic effects for each lactation, but may be less precise if animals differ in rate of maturity. Several countries now model the first three lactations as separate traits in published evaluations for yield traits. An alternative is to include a regression on maturity in traditional repeatability models. This allows data from five or even all lactations to be modeled by two genetic effects using single-trait rather than multi-trait programming. Maturity effects were scaled to measure the difference between first and second lactation yield, with smaller differences among later parities. The model was tested on US Jersey data of over 3 million lactation records. Maturity regression coefficients for lactations 1 to 5 were set to [-0.7 0.3 0.4 0.4 0.4] based on preliminary analysis. Parent averages calculated from calvings before 1999 were compared to February 2004 breeding values (BV) calculated from all records or from only first parity records. For bulls born since 1990 with reliabilities above 60% for the current evaluation, within birth year correlations were 0.01 to 0.02 higher for predicting first parity BV from a model with 8% of variance assigned to maturity effects than from a model without this effect. For most birth years after 1989, correlations were not higher for predicting the all parity BV from models with maturity effects as compared to the current repeatability model. A range of maturity variances from 2 to 16% was tested. If 8% of phenotypic variance was assigned to maturity effects, genetic correlations of first with second through fifth parity were assumed to be 0.89, 0.87, 0.87, and 0.87. Correlations among third through fifth were 1 and second with later were >0.99. This random regression approach accounts for genetic differences in rate of maturity with little computational expense, but most genetic parameters tested did not result in improved evaluations

Key Words: Parity, Random Regression, Maturity

738 Prediction of service sire fertility. M. T. Kuhn*¹, J. L. Hutchison¹, and J. S. Clay², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*, ²*Dairy Records Management Systems, Raleigh, NC.*

Estimated relative conception rates (ERCRs) are phenotypic predictions of service sire (SSR) fertility computed by Dairy Records Management Systems. ERCRs are based on first service 70-d non-return rate using a linear model that includes the fixed effects of herd-year-month of service, parity, days in milk at breeding, birth year of SSR, and energy-corrected milk yield and the random effects of animal (cow), permanent environment (PE) of the cow and SSR by herd interaction. The ERCR, then, is simply the SSR solution. This research investigated an alternative linear model using all services. The model included the fixed effects of herd-year-season of service, state-month of breeding, parity, and stud; the linear and quadratic effects of milk yield, days-in-milk at breeding, age of cow at breeding, age of SSR at breeding and the linear effects of expected future inbreeding of the daughters (EFI) and inbreeding coefficient of the SSR and also the random effects of animal (SSR), cow and PE of the SSR. A sire's predicted conception rate (CR) was calculated as the sum of his animal, PE, and stud solutions plus the regression on his age, his EFI, and his own inbreeding coefficient. Data for prediction was the result of breeding (0,1) for 530,380 Holstein cows calving between 1995 and 1997. For unconfirmed records, the last service was considered successful unless the cow was coded as sold for reproductive reasons. To assess accuracy of the predictor, mean CR in 1998 was calculated for each SSR and correlated with predicted CR. For bulls with at least 100, 500, and 1000 matings in the predictor, the correlation between predicted and actual CR in a future year was 0.16, 0.26, and 0.36, respectively. For bulls with breedings to at least 1000 cows, in contrast to just 1000 services, the correlation between predicted and future CR was 0.52. Further research will focus on other alternative models, appropriate data edits, and methods to handle the last service where pregnancy status is not known with certainty.

Key Words: Male Fertility

739 Estimation of the economic impact of a unit change in PTA for daughter pregnancy rate. E. Yook*¹, R. E. Pearson¹, and P. M. VanRaden², ¹Virginia Tech, Blacksburg, ²Animal Improvement Programs Laboratory, Animal Research Service, USDA, Beltsville, MD.

The economic impact of a unit change in PTA of daughter pregnancy rate (DPR) on lifetime profit estimates of a bulls daughters was estimated from DHI records for 71,094 cows to determine an economic weight for the PTAdpr in economic indexes. A cows relative net income (RNI) was calculated using all production initiated prior to her tenth birthday with milk-fat-protein pricing. The basic RNI function consisted of [total milk, fat, and protein income feed cost for production] (YI) + [net value of calves + net salvage value] (NYI) rearing cost (RC) [(daily cost for labor, maintenance feed, supplies, and fixed expenses)×days in herd] (DC). The basic RNI was augmented (ARNI) by adding the products of sire PTA for various traits and the net income for those traits proposed in the Net Merit calculation but not included in the basic RNI function; specifically, SCS(M), type composites (T), and DPR and daughter calving ease (PRCE). Regression analyses including herd and birth year in the model were used to estimate the simple and partial regressions of ARNI or partitioned ARNI on PTAdpr. Partial regression included all PTAs in Net Merit, except sire calving ease. Each 1% change in PTAdpr increased ARNI 23.64throughincreasingYIby90.44, NYI by 9.15, Mby5.26, T by 2.34, PRCEby4.51, and DC by 89.04anddecreasingRC0.98. Thus, ignoring other PTA left a substantial positive impact of PTAdpr. Correspondingly, changing PTAdpr by 1% barely broke even when other PTA were held constant because the loss in YI was greater than the savings in daily cost.

Regression coefficients (β) for y on PTAdpr

	Response (y)							
	ARNI	YI	NYI	RC	DC	M	T	PRCE
Simple	23.64	90.44	9.15	0.98	-89.04	5.26	2.34	4.51
Partial	1.81	-51.11	2.00	1.59	46.46	0.00	0.00	2.88

Key Words: Daughter Pregnancy Rate, Relative Net Income, Economic Weight

740 Genetic parameters for days open and pregnancy rate in US Holsteins. S. Oseni, I. Misztal*, S. Tsuruta, and R. Rekaya, *The University of Georgia, Athens.*

The influence of different editing of days open (DO) records on genetic parameters of DO and pregnancy rates (PR) in US Holsteins was investigated. Data included first parity 305-d milk yields and DO records in eight states: GA, FL, NC, TX, AZ, CA, NY, and WI. Pregnancy rates was computed as $1/[(DOX)/HI+1]$, where X was the approximate voluntary waiting period, and HI was the heat interval set to 21 d. Upper limit for PR was set to 1.0. A bivariate animal model with DO (or PR) and 305-d milk yield as dependent variables was fit separately for each state. The model included fixed effects of herd-year, month of calving and age of cow, and random animal and residual effects. In separate analyses, large DO records were limited to 150, 250 and 365 d. Additionally, analyses for PR used values of 50, 80 and 120 d for X. PR assigns more weight to small DO records, and larger heritability for PR indicates larger contributions of such records. Large changes in heritability when an interval was limited indicated genetic variability within that interval. Genetic and residual variances for DO were strongly dependent on the upper limit, with residual variances changing up to 10 times. Estimates of heritability for DO varied between 3 and 6%. Increase of heritability with the upper limit changing from 150 to 250 d was over 30% for FL and NC, and smaller to flat for the other states. The increase from 250 to 365 caused small changes. The genetic correlation between milk and DO was the highest for FL (0.6) and the smallest for GA (0.1 - 0.2). For PR with X=50, the heritability was higher than for DO for GA, equal for AZ, and smaller for the remaining

states. For most states, highest heritabilities for PR were obtained at X = 80 (NY, TX, WI) or X=120 (CA, FL, NC). Records of DO > 250 d carry little genetic information whereas records < 120 d carry more or less information depending on management. Days open and PR are strongly influenced by differences in management between states.

Key Words: Days Open, Pregnancy Rate, Genetic Parameters

741 Genetic relationships of milk yield for different parities between bulls and their sons. H. D. Norman*, R. L. Powell, J. R. Wright, and P. M. VanRaden, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

This research examined how bulls differ in rate of maturity of their daughters. The 305-d milk records for Holsteins with first parity calving dates between 1960 and 1998 were used to calculate three predicted transmitting abilities (PTA) for each bull. The first genetic evaluations included only first lactations on daughters and contemporaries (PTA₁). The second and third sets included the first two and three lactations available, PTA₁₋₂ and PTA₁₋₃, respectively. The contribution from individual parities, two (PTA₂) and three (PTA₃), were approximated using a weighted average of the (single trait) evaluations, PTA₁, PTA₁₋₂, and PTA₁₋₃. Weights were based on number of daughters with a second (or third) lactation. Bulls (2864) with ≥500 daughters ranged from +295 to -290 kg in difference between PTA₁₋₃ and PTA₁, with a SD of 85 kg. In contrast, when the same bulls were ranked on the differences between their contribution to separate parities, they ranged from +555 to -610 kg, for PTA₃ - PTA₁ with a SD of 179 kg. To determine if these difference were transmitted, comparisons were made across a generation. For 16,643 sons with ≥40 daughters, expected regressions of son PTA on sire PTA calculated within sire and son birth years (YOB) was 0.44. Actual regressions for PTA₁, PTA₁₋₂, PTA₁₋₃, PTA₁₋₂ - PTA₁, PTA₁₋₃ - PTA₁, and PTA₁₋₃ - PTA₁₋₂ were 0.44, 0.43, 0.43, 0.43, 0.43, and 0.42, most with standard errors (SE) = 0.01. Regressions were also derived on the bulls' specific contribution to second and third parities. Actual regression calculated within YOB for PTA₂, PTA₃, PTA₂ - PTA₁, PTA₃ - PTA₁, and PTA₃ - PTA₂ were 0.42, 0.44, 0.44, 0.45, and 0.43, most with SE = 0.01. These results suggest that differences observed in high reliability bulls as their daughters mature is transmitted to their sons daughters. Modeling separate PTAs for each parity should increase accuracy of, and reduce unnecessary oscillation in, genetic evaluations when number of records per daughter changes.

Key Words: Milk Yield, Parity, Lactation Number

742 Effects of udder traits on milk flow and their associations with temperament of first lactation dairy cows during milking time. B. rekik*, A. Ben gara, R. Bouraoui, and K. kouki, *ESA Mateur, Tunisia.*

The effects of the main udder traits of 120 first lactating Holstein-Friesian cows on milk flow were studied around the lactation peak using linear regression. Associations of these traits with temperament of cows during milking time were detected using logistic regression. Most of cows had an overall satisfactory mammary system. The main conformation traits of the udder were interrelated. Pearson correlation coefficients ranged from -0.59 (udder cleft with teat placement) to 0.30 (height with width of rear attachment). Mean milk flow was 22.50gr/s with a minimum of 9.14gr/s and a maximum of 36.81gr/s. This rate of yield production was found to vary with udder balance (P<0.05), rear udder width (P<0.01), side teat distance (P<0.05), and udder cleft (P<0.05). Milk was better extracted when udder traits tended towards optimal scores. The odds of an easy milking were four and five times greater than those of a difficult milking when teats are neither too long nor too short (P<0.05) and udder is balanced (P<0.01), respectively. Cows are more likely to get anxious at milking when their udders are not balanced and their teats are shorter or longer than an optimal length.

Key Words: Udder Traits, Milk Flow, Cow Temperament

743 Withdrawn by author. . .

744 Detection of quantitative trait loci affecting conformation traits in Holstein cattle. M. S. Ashwell^{1,3}, D. W. Heyen², T. S. Sonstegard³, C. P. Van Tassell³, and H. A. Lewin², ¹North Carolina State University, Raleigh ²University of Illinois, Urbana ³USDA-ARS, Beltsville.

Putative quantitative trait loci (QTL) affecting conformation traits in Holsteins have been detected using genotypic data generated by two research groups. Each research group conducted an independent genome scan in a select group of Holstein grandsire families. Six families were used by both groups and genotyped for 367 microsatellite markers in order to identify QTL affecting milk production and health traits. The same merged dataset has now been reanalyzed to identify putative QTL affecting conformation traits. Seventeen linear traits and four composite index traits were included in the analysis. The phenotypes were obtained from the Holstein Association USA (<http://www.holsteinusa.com>) and included standardized transmitting abilities for body type, feet and legs, and udder traits. Data were analyzed using QTL Express (<http://qtl.cap.ed.ac.uk>), a web-based regression interval mapping method. Preliminary analysis had identified 34 putative QTL affecting the conformation traits within the grandsire families. These QTL were significant at the chromosome-wise level (F -statistic > 15) and were located on 15 bovine autosomes. Additional analysis is underway to determine which of these QTL, if any, are significant at the genome-wise level.

Key Words: Conformation Trait, Quantitative Trait Loci, Dairy Cattle

745 Statistical power for detecting epistasis QTL effects under the F2 design. Y. Mao* and Y. Da, *Department of Animal Science, University of Minnesota, St. Paul.*

Epistasis refers to gene interaction effect involving two or more genes. Statistical methods for mapping quantitative trait loci (QTL) with epistasis effects have become available recently. However, little is known about the statistical power and sample size requirements for mapping epistatic QTL using genetic markers. In this study, we developed analytical formulae to calculate the statistical power and sample requirement for detecting each epistasis effect. The genetic modeling of QTL genotypic values and variance used the linear partition of Kempthorne (1954), and Bulmers presentation of this linear partition (1980) was used for efficient derivation of variances and covariances. To achieve succinct mathematical expressions and intuitive interpretations, epistasis heritability is defined to denote the ratio of the epistasis variance to the phenotypic variance. Assuming two interactive QTL without linkage and all epistasis effects have the same absolute value, the heritability of additive x additive (a x a) effect is about twice as large as that of additive x dominance (a x d) or dominance x additive (d x a) effect, and is about four times as large as that of dominance x dominance (d x d) effect. Consequently, among the four types of epistasis effects involving two loci, a x a effect is the easiest to detect whereas d x d effect is the most difficult to detect. The statistical power for detecting a x a effect is similar to that for detecting dominance effect of a single QTL. The power is poor for detecting a x d or d x a effect and is extremely poor for detecting d x d effect. The sample size requirements for detecting a x d, d x a and d x d are highly sensitive to increased distances between the markers and the interacting QTLs. Therefore, using dense marker coverage is critical to detecting those effects.

Key Words: Epistasis, QTL, Statistical power

746 Including genetic groups for QTL effects in marker assisted selection. K. J. Hanford¹, R. M. Thallman², S. D. Kachman³, and L. D. Van Vleck¹, ¹USDA-ARS, Roman L. Hruska U.S. Meat Animal Research Center, University of Nebraska, Lincoln, ²USDA-ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE, ³Department of Statistics, University of Nebraska, Lincoln.

Genetic group effects provide a means of accounting for the effect of selection that cannot be accounted for by records of relatives. In a polygenic animal model, genetic group effects are incorporated into the

mixed model equations (MME) by adding one equation for each genetic group corresponding to foundation (phantom) animals. With minor modifications the rules for the inverse of the relationship matrix without genetic groups can be used to obtain the inverse of the coefficient matrix after absorption of the equations for the phantom animals needed for solving the MME. With identification of quantitative trait loci (QTL), information from closely linked genetic markers can be included in prediction of breeding values with mixed model equations to implement marker assisted selection (MAS), where effects of QTL alleles are considered random. As with the polygenic animal model, the distribution of the QTL alleles can be different within different subpopulations. Genetic group effects for the QTL may also arise from QTL effects that depend on the genetic background of the different subpopulations. Current methods for MAS with solutions from mixed model equations do not allow for incorporating genetic group effects for QTL. An extension has been developed which allows genetic group effects to be incorporated in the MME to obtain genetic evaluations for MAS by augmenting the MME by the number of genetic groups used in models without marker information. Rules for constructing the inverse of the QTL coefficient matrix after absorption of the equations for the phantom animals and augmenting the MME with this matrix have been derived and will be presented.

Key Words: BLUP, Genetic Groups, MAS

747 Computational analysis of putative imprinting signatures of bovine IGF-II and IGF-II receptor genes. I. G. Imumorin¹, J.J. Kim², O. O. Mgbere³, and D. O. Umehiobi⁴, ¹Valdosta State University, Valdosta, GA, ²Iowa State University, Ames, ³Rivers State University of Science & Technology, Port Harcourt, Nigeria, ⁴University of Natal, Pietermaritzburg, South Africa.

The IGF-II gene and its receptor (IGF-IIR) are members of the insulin family of polypeptide growth factors and also represent two of the earliest imprinted genes identified in mice and later in humans. The IGF-II gene has been shown to be paternally expressed in sheep and pig, but yet to be tested experimentally for genomic imprinting in cattle, whereas maternal expression of IGF-IIR has been reported in a single uncorroborated study in cattle. We conducted preliminary computational analysis of five concatenated cDNA sequences of bovine IGF-II and a full length cDNA sequence of bovine IGF-IIR downloaded from GenBank to gain some insight into putative imprinting signatures of both genes. A total of 2,451 nucleotides of the IGF-II gene and 9,061 nucleotides of IGF-IIR were analyzed. These cDNA sequences were searched for motifs that may be common with genomic sequences of human and mouse IGF-II and IGF-IIR genes using MEME analysis and the motif weight matrix outputs from MEME analyses were subjected to analysis by the MAST program. The MAST analysis identified highest scoring motif sequences of 200 bases for IGF-II and 166 bases for IGF-IIR, which were analyzed by EMBOSS-CpG Plot program respectively. IGF-II contained a 61-base CpG island, with a GC content of 67% and an observed/expected CpG ratio of 0.78. No CpG island in the IGF-IIR motif sequence was identified. This might indicate a differentially methylated region (DMR) in the bovine IGF-II promoter, which is a common signature of imprinted genes. However, a more accurate and robust analysis of these genes awaits the full bovine genomic sequences for comparison with conserved non-coding but regulatory sequences of the mouse and human orthologs of IGF-II and IGF-IIR genes, which in turn require experimental validation of imprinting status.

Key Words: Imprinting, Bovine IGF-II, Bovine IGF-II Receptor

748 Evaluation of microsatellite markers on bovine chromosomes 1 and 5 for potential allelic associations with meat characteristics and growth traits in beef cattle. K. S. Kim¹, S. Costello², G. J. M. Rosa¹, A. M. Mullen², N. E. Raney¹, and C. W. Ernst¹, ¹Michigan State University, East Lansing, ²National Food Centre, Dublin, Ireland.

Association between molecular marker and phenotypic data is an important tool to expedite genetic improvement of livestock species. Several bovine chromosomal regions (QTL) have been reported to have significant associations with growth and performance traits in cattle. In this study, potential effects of previously identified QTL regions on growth

and beef quality traits were investigated in commercial beef cattle populations. Eight microsatellite markers spanning QTL regions on bovine chromosomes (BTA) 1 and 5 were genotyped in beef cattle populations from Michigan and the Republic of Ireland. Haplotypes of these markers were constructed using the PHAGE program (www.gmap.net). Analyses of allelic associations with phenotypes were performed with chi-square tests to compare allelic frequencies between groups with high and low phenotypic values. Initial analyses have been performed with the Michigan (n=85) and Irish (n=75) data sets. In the Michigan data, the BTA1 markers exhibiting significant allelic frequency differences were BM1312 for slaughter weight ($P < 0.06$), BMS6506 for birth weight ($P < 0.06$), and BMS4048 for hot carcass weight ($P < 0.05$). Significant associations of these markers with meat quality traits from the Irish cattle were also found with BM1312 for firmness ($P < 0.003$), BMS4001 for flavor ($P < 0.005$) and texture ($P < 0.05$), and BMS4048 for pH ($P < 0.05$). A haplotype of BM1312-BMS4001 markers also revealed a significant allelic difference for firmness ($P < 0.01$) and texture ($P < 0.05$) traits. Significant differences in allelic frequency from BTA5 markers were found with BL4 for flavor ($P < 0.05$), and ETH10 for intramuscular fat % ($P < 0.05$). Our results suggest that QTL reported on BTA 1 and 5 may be segregating in commercial beef cattle populations and their effects may extend to economically important meat quality traits. Thus, further study is warranted to define beneficial haplotypes for potential use in marker assisted selection to improve these traits in beef cattle.

Key Words: Beef Cattle, Microsatellite Markers, Beef QTL

749 A combined line-cross and half-sib model to detect and characterize QTL in an F2 outbred cross population. J.-J. Kim* and J. C. M. Dekkers, *Iowa State University, Ames.*

Data from an F2 outbred cross is typically analyzed by a least squares line-cross (LC) model to detect QTL that differ between breeds. Alternatively, data can be analyzed by a half-sib (HS) model for F1 sires to allow for QTL segregating within breeds. The LC and HS models can also be combined (CB model). Objectives of this study were to evaluate the power to detect QTL and to characterize QTL into LC, HS, or CB QTL, i.e. QTL that are fixed, segregating at similar or different frequencies in the parental breeds, using model lack-of-fit tests. Phenotypic and marker data for a 100 cM chromosome with 11 equidistant markers were simulated on 512 F2 progeny for two mating designs: I (II): 2 (20) F0 sires, 10 (80) F0 dams, 8 (19) F1 sires. A biallelic QTL was simulated at 75 cM with additive values of 0.8, 0.5 or 0.32 phenotypic SD. A total of 6000 replicates were generated with the actual difference in QTL allele frequencies (FD) between the alternate F0 parents ranging from 0 to 1. Significance thresholds were from 3000 simulations without QTL. The LC model was most powerful for any size fixed QTL (FD=1) in both designs, followed by the CB model. For FD =0.5, the CB model was more powerful than the HS and LC models (99, 97 and 97% for the large QTL for CB, HS, LC; 84, 76 and 68% for the medium QTL; 44, 40 and 35% for the small QTL, in design I). For FD=0, the HS model had more power than the CB and LC models (74, 70 and 10% for the medium QTL for HS, CB, LC; 30, 22 and 7% for the small QTL in design I). For FD=1, most detected QTL were defined as LC QTL in both designs. This proportion decreased with FD. The opposite was observed for HS QTL. The proportion CB QTL among detected QTL was greatest for FD=0.5 and decreased as FD moved away from 0.5. The latter was more pronounced for the large than the small QTL, for which the proportion of CB QTL was nearly constant across FD. Our results show that the CB model can increase power to detect QTL and enables characterization of QTL detected in F2 crosses that segregate within breeds.

Key Words: QTL Mapping, Line-Cross Half-sib Analysis, Combined Model

750 Identification of an ovulation rate QTL in cattle on BTA14 using selective DNA pooling and interval mapping. M. G. Gonda*¹, J. A. Arias², G. E. Shook¹, and B. W. Kirkpatrick², ¹*Dairy Science Department, University of Wisconsin-Madison*, ²*Animal Sciences Department, University of Wisconsin-Madison.*

Increased twinning incidence in beef cattle has the potential to improve production efficiency. However, phenotypic selection for twinning rate is difficult because of the traits low heritability and the long time interval necessary to collect phenotypic records. Therefore this trait and

the correlated trait of ovulation rate are ideal candidates for marker-assisted selection. The objective of this study was to identify ovulation rate quantitative trait loci (QTL) in two related sire families. The families (paternal half-sib sires 839802 and 839803) were from a population of cattle selected for ovulation rate at the USDA Meat Animal Research Center, Clay Center, Nebraska. Putative ovulation rate quantitative trait loci have previously been identified in the 839802 family on chromosomes 7 and 19; however, marker coverage in the original scan was not complete. This study fills the gaps in marker coverage of the earlier study by adding approximately 60 informative microsatellites to each sire family. Each family was genotyped using selective DNA pooling. Sons and daughters were included in either the high or low pool based on their estimated breeding value deviations from the midparent average (EBVMD) for ovulation rate. Approximately 40% (839802) and 26% (839803) of available progeny comprised the high and low pools combined. Pooled typing revealed possible associations (nominal $P < 0.05$) between ovulation rate and marker genotype for eleven and fifteen microsatellites in the 839802 and 839803 families, respectively. Subsequent interval mapping provided additional support for the presence of an ovulation rate quantitative trait locus on BTA 14 (chromosome-wise $P < 0.02$).

Key Words: Ovulation Rate, Quantitative Trait Locus, Selective DNA Pooling

751 Power and sample size calculations for two color microarray experiments with biological and technical replication. J. P. Steibel*¹, R. J. Tempelman¹, and G. J. M. Rosa^{1,2}, ¹*Department of Animal Science, Michigan State University, East Lansing*, ²*Department of Fisheries and Wildlife, Michigan State University, East Lansing.*

Very recent work on sample size and power calculations for microarray experiments have simply considered arrays or spots as the experimental units. Nevertheless, biological replicates should be considered to be the fundamental experimental units when broad inferences are of interest. In other words, dye-swap arrays on the same two samples and or multiple spots per gene on a slide should be treated as subsamples. We address sample size calculation and analysis of microarray experiments using linear mixed effects models, with special attention directed towards the distinction between biological replication and technical replication within a broad inference context. Three experimental designs were considered: 1) the Loop design, 2) the Dye swap design, 3) and the Reference design. Power was determined for three levels of differential expression (1.25, 1.5 and 2.0 fold-change), and for several different levels of biological replication ($n = 2, 10$) and technical replication ($r = 1, 4$) based on five different sets of variance components. Results for the loop and the dye swap experiments were virtually identical with slight differences depending on, whether or not Satterthwaites approximation to degrees of freedom was used. The reference design, however, provided the lowest power of test in almost all situations, particularly when the residual variance was large. Increasing technical replication yielded very marginal improvements in power except in situation with high residual variance. Our power analysis indicates that in situations of relatively high biological variability, as many as 40 individuals per treatment are necessary to have at least an 80% probability of concluding differential expression on a gene with 1.25 fold change. This result is particularly relevant for experiments involving livestock species, in which the biological variance (animal-to-animal variability) is generally considerably larger than the technical variance (variability among arrays and among spots). In this situation, the only meaningful way to improve experimental power is by increasing the number of animals in the trial.

Key Words: Microarray, Power Analysis, Biological Replication

752 A new method to fine map a quantitative trait locus using linkage disequilibrium. H. Gilbert*^{1,2}, M. Z. Firat², L. R. Totir², J. C. M. Dekkers², and R. L. Fernando², ¹*Institut National de la Recherche Agronomique, Cedex, France*, ²*Animal Science, Iowa State University, Ames.*

A new approach was developed to fine map a biallelic QTL using linkage disequilibrium (LD). It uses the probability that a maternal (paternal) QTL allele of each individual is the mutant QTL allele, conditional on the pedigree and marker information. These probabilities were derived recursively from the haplotype-specific mutant QTL allele frequencies in the founders. As the haplotypes of founders are not known, their

probabilities were estimated by MCMC methods. This model has fewer parameters than the usual model, because it relates the means and covariances of the QTL gametic values to the QTL allele effect and their frequencies. Consequently, this approach is expected to be more accurate. To overcome the computing difficulties in exact calculation of IBD probabilities, an MCMC method was used to derive approximate conditional probabilities of inheriting maternal and paternal QTL alleles. A residual maximum likelihood method (REML) was implemented to map the QTL, using a Newton-Raphson algorithm. The QTL position, QTL effect, haplotype-specific mutant QTL allele frequencies and polygenic and residual variance components were jointly estimated for each interval. The derivatives of the residual likelihood were obtained by automated differentiation. A simulated population was analyzed to compare the ability of this technique to fine map a QTL with two others methods. In the first method, identity by descent QTL covariances are used to model LD and cosegregation of the alleles at linked loci. In the second, identity by descent QTL covariances are used only to model the cosegregation of the alleles, and LD is modeled by including the marker haplotypes as fixed effects in the model. LD was simulated by introducing a mutation at the QTL followed by 100 generations of random mating. Different genetic designs were simulated, under linkage and linkage disequilibrium and with various QTL effects, to obtain power and accuracy of the parameter estimates.

Key Words: QTL, Linkage Disequilibrium, Simulation

753 Assessment of respiratory chain complex activities and electron transport chain protein expression in muscle mitochondria in Angus steers with low and high feed efficiency. B. A. Sandelin^{*1}, A. H. Brown Jr¹, C. Ojano-Dirain¹, M. Iqbal¹, M. A. Brown², W. O. Herring³, M. Akin⁴, Z. B. Johnson¹, and R. T. Baublits¹, ¹University of Arkansas, Fayetteville, ²USDA-ARS Grazinglands Research Laboratory, El Reno, OK, ³Smithfield Premium Genetics Group, Roanoke Rapids, NC, ⁴Circle A Angus Ranch, Iberia, MO.

The objectives of this study were to determine the relationships between feed efficiency (FE, gain/feed) and respiratory chain complex activity and mitochondrial protein expression in cattle. Feed efficiency was determined on 92 head of contemporary Angus steers fed over a 130 d period. Individual animal intake was measured by a Calan Broad-bent Feeding system. Animals were fed five finishing rations (stepwise) throughout the feeding period. Animals were harvested at a commercial packing plant and muscle (Sternohyoideus) samples were obtained from steers with Low (0.154 ± 0.02 , $n=7$, L) and High (0.252 ± 0.02 , $n=7$, H) FE. Muscle homogenate and mitochondria were isolated using differential centrifugation. Activities of respiratory chain complexes were measured using spectrophotometric methods. The protein bands were separated in 10% SDS-PAGE, stained with Coomassie blue and intensities were quantified using Scion software. Mitochondrial protein expressions were assessed with Western blot analysis with a chemiluminescence detection system. Activities of respiratory chain Complexes (I and II) were higher ($P < 0.02$) in L compared to H steers. While the expression of four immunoreactive mitochondrial proteins, NAD4 (Complex I), core I (Complex II), Cox II (Complex IV), ANT1 (ADP/ATP channels), were higher ($P < 0.05$) in N compared to L steers, there were no differences in the expression of several other proteins. SDS-PAGE revealed that the intensities of seven protein bands were higher in H compared to L steers. It appears that differences in complex activities and protein expressions may be involved in the phenotypic expression of feed efficiency in cattle.

Key Words: Feed Efficiency, Angus, Muscle Mitochondria

754 Samples classification using microarray data: Dealing with potential diagnostics misclassification. R. Rekaya^{*}, Department of Animal and Dairy Science, University of Georgia, Athens.

While microarray was successfully applied in gene expression profiling of tissues/cells, and methods for selecting a subset of discriminative genes

for samples classification have been proposed, the robustness of those procedures to potential misclassification was never investigated. For complex and heterogeneous responses such as disease traits, several subclasses with varying phenotypes exist. Using typical diagnostics tools, different types of a specific disease/trait can be difficult to tell apart. As a result, such similarity can lead to misdiagnosis. It is recognized that an accurate diagnostic is crucial for a successful use of gene profiling as a classification tool. Unfortunately, the accurate assignment of a subject to a specific disease/trait type is a difficult and expensive process. Although, the results obtained using microarray seem to indicate a more accurate prediction, the problem of misclassification is not yet resolved. This type of ambiguity is not rare, and it is either too difficult to detect, or economically unfeasible. In gene expression experiments involving animals, and even human, the present cost of the technology precludes extensive testing. In this study, a method for dealing with this problem or at least to attenuate its effects using a statistical model capable of accounting for potential misclassification was implemented. A simulation was conducted where 30 arrays with 10,000 genes each were generated. In the first case, a binary response was assumed. In the second case, a multinomial response with 5 classes was assumed. In both cases, the status for every sample was assigned as a function of the gene expression intensities in each array. Artificially, some samples status was changed randomly to introduce a misclassification rate of 5% and 10%. When the miscoded data was analyzed without consideration of misclassification, a change of 20-35% of discriminative genes was observed depending on the type of trait and the percentages of miscoding. When the miscoded data was analyzed with a model that contemplated misclassification, the change in the set of discriminative genes ranged from 2-8% depending primarily on the miscoding rate.

Key Words: Microarray, Misclassification, Gene Expression

755 Statistical methods to detect imprinted QTL with gender-specific recombination frequencies. Nicole R. London^{*} and Yang Da, Department of Animal Science, University of Minnesota, St. Paul.

Imprinting is characterized by differential expression of alleles due a parent-of-origin effect. In this study, we developed statistical methods to detect and map imprinted quantitative trait loci (QTL) accounting for gender-specific recombination frequencies under the F2 and reciprocal backcross (RBC) designs. Multi-allelic markers were assumed for both designs. Under the F2 design with gender-specific recombination frequencies, additive and imprinting effects are confounded using currently available contrasts for testing additive and imprinting effects. Alternative contrasts were developed to independently estimate these effects. These contrasts are functions of gender-specific recombination frequencies, and reduce to the currently available contrasts when the two genders have equal recombination frequency. The RBC design requires a reciprocal mating system in terms of parental gender to detect imprinting effect. Contrasts for use with the RBC design were developed to independently test for additive and imprinting effects. These models were used to analyze a simulated population of animals. Monte Carlo simulation studies were conducted to evaluate the theoretical results on statistical power for detecting additive, dominance, and imprinting effects under the F2 and RBC designs. Marker and QTL genotypes were generated such that the true recombination frequency and each QTL effect used to generate these genotypes could be obtained reversely from the data. The analysis of the data showed the methods are accurate and computationally feasible to use with large data sets. Statistical powers observed from the simulated data agreed well with predicted powers. The power depends on the effect size, heritability of the trait, and the marker QTL recombination frequency. An F2 design has higher power than a RBC design to detect imprinting effects. The sample size necessary to detect imprinting effects is similar to the requirements to detect additive effects.

Key Words: Imprinting, QTL, Recombination frequency

756 Comparison of viscosity and stability of bovine fluid and evaporated milks with those of caprine milk counterparts stored under refrigeration. C. O. Maduko*¹, R. Shewfelt¹, R. Toledo¹, J. Frank¹, Y.-W. Huang¹, and Y. W. Park², ¹Department of Food Science and Technology, University of Georgia, Athens, ²Agricultural Research Station, Fort Valley State University, Fort Valley, GA.

Heat coagulation of milk results from a complex series of physico-chemical reactions that eventually lead to precipitation or gelation. Viscosity of milk tends to increase upon heating as it approaches the point of coagulation of the proteins, which is the basis for producing high viscosity in super-heated condensed milk. Although viscous property may have been studied extensively in cow fluid milk, relatively little information is available on viscosities of concentrated milks and comparison of those of different species milks. Commercial cow and goat fluid milks and their evaporated products were purchased from retail outlets to study characteristics of viscosity and physico-chemical stability of bovine milks compared to caprine counterparts stored at 4 and 13°C refrigeration for 4 weeks. The respective initial viscosity values for bovine fluid (BF), evaporated (BE), and caprine fluid (CF), evaporated (CE) milks were: 1.54, 1.55, and 1.72, 2.03 centipoises, indicating that goat milk products had higher viscosity values than cow counterparts. The viscosity of BF was gradually increased until day 12 at 4°C, and the increase continued to day 28 during which gelation occurred. The BE was stable till day 28 at 4°C storage and did not undergo gelation during this period. The viscosity of CF increased slightly under refrigeration until day 7, then decreased gradually to the lowest at day 11. A sharp increase in viscosity occurred from day 12, and continued to day 28 of storage, during which gelation of the CF milk occurred. However, CE did not show a noticeable decrease on day 9 and remained physically stable until day 28 of storage without any gelation. The refrigeration temperatures had minimal effect on the viscosities of the tested milks. The evaporated milks had greater physical stability under refrigerated storage relative to fluid milks. This may be attributable to the fact that heat treated milk products are actually electrodialysed before evaporation, whereby the partial removal of soluble salts by dialyzing milk against water increases the heat stability when the milk is subsequently concentrated.

Key Words: Viscosity, Bovine and Caprine Milk, Refrigerated Storage

757 Immunostimulatory activities of a novel AT oligonucleotide from “Immunobiotic” *Lactobacillus gasseri* on swine Peyer’s patch cells. H. Kitazawa*, T. Shimosato, S. Katoh, M. Tohno, Y. Kawai, and T. Saito, *Graduate School of Agricultural Science, Tohoku University, Sendai, Japan.*

Many works in the biological functions of dairy lactic acid bacteria (LAB) have contributed to the application of LAB as functional foods and supplements in the worldwide market. More recently, the new term “immunobiotics”, identifying probiotic bacteria that promote health through activation of the intestinal immunity compared to those with strictly local immunity, has been proposed and expected for an appropriate evolutionary development. We have studied specific effector molecules and their receptor targets. Recently, we have found that immunostimulatory AT oligonucleotide (ODN), but not CpG ODN, from *Lactobacillus gasseri* JCM1131^T triggered B cell mitogenic responses in mice. This finding suggests the possibility that the AT ODN could activate the immune responses in peyer’s patches, which belong to a gut associated lymphoid tissue. The present study was conducted to elucidate the immunostimulatory ability of AT ODN in swine peyer’s patches as a human model. The AT ODN significantly augmented the mitogenic activity of swine peyer’s patch cells, when they were stimulated at 10 μ M of ODN, as well as D25, which is known to be an optimal active CpG ODN for swine. The AT ODN strongly induced IL-6, 12p40 and IFN γ gene expressions in swine peyer’s patch cells. Preferential expression of Toll like receptor 9 (TLR9), which is a receptor for unmethylated CpG ODN, was detected in peyer’s patches by the real-time quantitative PCR and immunohistochemical analysis. These findings suggest a possibility that the AT ODN could regulate Th1/Th2 responses in the gut via TLR9 signaling as well as CpG ODN, which is expected play an important role in the prevention of infectious and allergic diseases. This study demonstrated that *Lactobacillus gasseri* JCM1131^T was a good

candidate for the production of new functional foods, “Immunobiotic Foods”.

Key Words: Immunobiotics, DNA, *L. gasseri*

758 AT oligonucleotide from “Immunobiotic” *Lactobacillus gasseri* augments immune responses via Toll-like receptor 9 signaling. T. Shimosato*, H. Kitazawa, M. Tohno, S. Katoh, Y. Kawai, and T. Saito, *Graduate School of Agricultural Science, Sendai, Japan.*

Toll-like receptor (TLR) 9 has been identified as a particular receptor for bacterial DNA that contains a specific sequence pattern, unmethylated CpG dinucleotide. From the discovery of TLR9, possible molecular mechanisms in immune responses through bacterial DNA have been rapidly revealed in mice. Recently, we have found the possibility that AT oligonucleotide (ODN), which was a non-CpG ODN from *Lactobacillus gasseri*, induced immunoactivation in peyers patches (Pps) via TLR9. In the present study, to elucidate the role of TLR9 with AT ODN in the intestinal immunity, we performed the following studies. First, we isolated a cDNA encoding a TLR9 from swine Pps, which are considered to be useful for human models. The total RNA was isolated from the Pps of adult swine intestine. The complete open reading frame of sTLR9 contains 3090bp coding and deduced 1029 amino acid residues with a calculated molecular mass of 115.7kDa. Next, we constructed a transfectant of swine TLR9 with mammalian cells for the development of an immunoassay against ODN. We demonstrated that the transfectant recognizing not only CpG but also non-CpG AT ODN from Lactic acid bacteria (LAB) resulted in the induction of NF- κ B activation by gene reporter assay. Furthermore, TLR9 was strongly detected in the follicle-associated epithelium including M cells as well as antigen presenting cells such as dendritic cells in Pps. These findings indicate that the TLR9 positive cells in Pps provide the host defense with the ability to respond to a variety of ODN from the Immunobiotic LAB. This study firstly shows that TLR9 is a receptor for not only CpG but also for non-CpG AT ODN and may help in understanding the intestinal immunoregulation mediated by Immunobiotic LAB DNA through TLR9 for a development of Immunobiotic Foods.

Key Words: TLR9, Swine, Oligonucleotide

759 Extending shelf life of skim milk with micro-filtration. M. W. Elwell* and D. M. Barbano, *Northeast Dairy Foods Research Center, Department of Food Science, Cornell University, Ithaca, NY.*

The objective of the research was to determine the efficacy of a micro-filtration and pasteurization process in extending the shelf life of skim milk. Raw skim milk (ca. 273 kg) from the Cornell University dairy plant was microfiltered at 50°C using a Tetra Alcross M7 Pilot Plant equipped with a ceramic Membralox membrane (pore diameter: 1.4 μ) and collected directly into a sterile container. Approximately 95 percent of the milk was collected as permeate. The collection container was connected directly to a shell and tube pasteurization system. The 50°C permeate was pasteurized at 72°C for 15 s, and collected directly into another sterile container. The experiment was replicated 3 times. Bacteria counts of raw skim were done by standard plate count. Bacteria counts of microfiltered and pasteurized microfiltered milk were determined using a most probable number (MPN) method. For the MPN method, five containers each with 1, 10, 100 and 500 mL of milk were incubated at 32°C for 6 days. Growth or no growth in each container was determined using a Foss BactoScanTM FC. The MPN bacteria count was calculated using a spreadsheet developed by FDA/CFSAN. Bacteria count of the raw milk was reduced from 2400, 3600, and 1475 cfu/mL to 0.2398, 0.9178, and 0.2398 cfu/mL, respectively, by microfiltration. Bacterial counts in the pasteurized microfiltered skim milk for the three trials were 0.0046, 0.0078, and 0.0045 cfu/mL respectively, demonstrating an average 5.6 log reduction from the raw count due to the combination of microfiltration plus pasteurization. The pasteurized microfiltered skim milk was pumped directly from the sterile collection container into 1L sterile sample containers for shelf life tests. Two sample containers were

incubated at each of four temperatures (0, 2, 4, and 6°C) and the total bacteria count was determined weekly until the count reached 10⁶ cfu/mL.

Key Words: Microfiltration, Shelf Life, Pasteurization

760 Descriptive analysis of processed cheese manufactured by extrusion technology. A. C. Cole*¹, K. A. Adhikari², I. U. Gruen¹, and H. Heymann³, ¹University of Missouri, Columbia, ²California State Polytechnic University, Pomona, ³University of California, Davis.

The use of extrusion technology to manufacture processed cheese has rarely been utilized in the US dairy industry. Extrusion technology ought to be explored for the continuous manufacture of processed cheeses, which might result in greater uniformity of the product as well as use in unique applications that are not feasible with current technology. The objective of this study was to determine and compare the physical and sensory characteristics of extruded processed cheese to those of a conventional processed cheese. Processed cheese was manufactured by blending one month, three month, and six month old Cheddar cheeses in the ratio 1:2:1, respectively. A twin screw co-rotating extruder was used to manufacture the experimental cheeses at two temperatures (80 and 90°C), two moisture levels (44 and 48%) and two melting salt levels (1 and 1.5%). Velveeta was used as the control. In total, nine processed cheese samples were tested. Descriptive sensory analysis was performed to identify the sensory characteristics of the processed cheeses by a panel of nine trained judges. Texture profile analysis (TPA) was performed to determine the physical characteristics of the cheese samples. Canonical variate analysis (CVA) was done to find differences among the processed cheeses using SAS, and partial least square (PLS2) regression was done to correlate the sensory data to the physical data. The CVA biplot showed that the high moisture and the low moisture cheeses were separated into two distinct clusters. The control was an outlier. The cheeses with high moisture levels were judged to have a cooked flavor, a sour aftertaste, and to be bitter, moist, and chewy. The cheeses with low moisture levels were found to be buttery, hard, and springy. The control was judged to be sweeter than the experimental cheeses. PLS2 indicated that the physical characteristics of hardness, springiness, and chewiness were highly correlated with the same sensory characteristics, while the physical and sensory characteristics of adhesiveness, gumminess, and cohesiveness were not correlated with physical texture measures.

Key Words: Descriptive Analysis, Processed Cheese, Extrusion Technology

761 Developments in the small scale manufacture of process cheese using RVA. R. Kapoor*, A. Pollard, P. Upreti, and L. E. Metzger, MN-SD Dairy Foods Research Center, University of Minnesota, Saint Paul.

Recently, methodology utilizing a Rapid Visco Analyzer (RVA) was developed that could be used to manufacture and analyze process cheese on a small scale (25 g). Although this methodology was successfully used to manufacture process cheese, a significant difference in the functionality of the process cheese was observed when compared to process cheese produced on a pilot scale. In the present study, adjustments in the RVA methodology involving the RVA processing conditions, preblend preparation and Texture Profile Analysis (TPA) techniques for the final process cheese were investigated. Three replicates of process cheese food (PCF) were manufactured from eight different pre-blends. Each pre-blend was prepared using eight different natural cheeses and was balanced for moisture (43.5%), fat (25%) and salt (2%). These pre-blends were split into three portions and each portion was subjected to three different manufacturing treatments. Treatment 1 (T1) was manufactured in the Blentech twin screw (BTS) cooker, whereas treatment 2 (T2) and treatment 3 (T3) were manufactured in the RVA using different processing profiles. T2 and T3 were produced in triplicate. The resulting process cheeses were analyzed for their chemical and functional properties. PCF produced in the BTS was analyzed for moisture, fat and salt whereas the PCF produced in the RVA was analyzed for moisture. There were no significant differences ($p \#8805 .05$) in the moisture content of PCF among the 3 treatments with each of the eight batches (produced from the eight different pre-blends). TPA and RVA melt analyses were performed on all the PCF. The batch of natural cheese

used had a significant effect ($p < .05$) on both the TPA-hardness and hot apparent viscosity of the PCF manufactured using the three treatments. Additionally, all three treatments indicated a similar ranking for the eight batches. The adjustments in the RVA methodology produced process cheese with functionality similar to the process cheese produced in the BTS and the RVA methodology was able to identify differences in functional properties of PCF caused by the use of different natural cheeses.

Key Words: Process Cheese, Rapid Visco Analyzer

762 Evaluation of process cheese spread meltability using a Rapid Visco Analyzer. L. A. Prow* and L. E. Metzger, University of Minnesota, St. Paul.

The melt characteristics of process cheese spread are an important functional attribute. Currently, there remains a need for a fast, accurate and low cost test to evaluate cheese meltability. The objective of this study was to develop a melt test for process cheese spread using a Rapid Visco Analyzer (RVA). The melt properties of 32 commercial process cheese spread and process cheese product samples from four different manufacturers were analyzed with the RVA, tube melt test and dynamic stress rheometry (DSR). Three replicates using the RVA, five replicates using the tube melt test and two replicates using DSR were performed on each sample. In the RVA melt test a 15 g cylinder of cheese was packed into the RVA canister and then subjected to a heating, holding, and cooling profile during continuous mixing. During the test an apparent viscosity vs. time graph was obtained. The melt time, hot viscosity, and time at 5000 cP were determined from each apparent viscosity vs. time curve. The tube melt test determines cheese flow in mm, whereas the DSR data was used to calculate cheese melt temperature (temperature at $\tan \delta = 1$). There was a high correlation (.91) between the DSR cheese melt temperature and the tube melt test. There was also a high correlation between the RVA melt time and the other melt tests (.84 and .74 for the DSR and tube melt test respectively). The RVA melt test also measures the apparent viscosity of melted cheese at a constant temperature (hot viscosity). The data obtained for hot viscosity had a low correlation (< .44) with the data from other melt test, which indicates that an additional cheese melting property may be measured. The results of this study indicate that RVA melt analysis of process cheese spread or process cheese product is correlated with the results from other melt test, but it may also provide additional information on cheese meltability which is not quantified in other melt tests.

Key Words: Process Cheese, Melt Analysis

763 A microfiltration (MF) process to maximize the removal of serum proteins from skim milk prior to cheese making. B. K. Nelson* and D. M. Barbano, Northeast Dairy Foods Research Center, Cornell University, Ithaca, NY.

MF of milk before cheese making using a 0.1- μ m pore size (ceramic) partially removes serum proteins (SP). The SP (mostly β -lactoglobulin and α -lactalbumin) do not contain residual starter, color, coagulant, and lactic acid from cheese making. Diafiltration (DF) has been used to remove lactose from whey protein retentates during ultrafiltration (UF) using water as the diafiltrant. Water as a diafiltrant has been used to remove SP from skim milk during MF, but this produces a retentate with lower lactose and unbound mineral content than milk and may have a negative impact on conventional cheese making. We hypothesize that high recovery of the SP from skim milk prior to cheese manufacture could be achieved by using permeate from the UF of MF permeate as the diafiltrant instead of water to maintain the lactose and unbound mineral balance of the retentate for cheese making. Pasteurized skim milk was single pass processed to a 3X concentration factor using MF. Permeate from MF was collected and ultrafiltered to produce UF permeate that was used as a diafiltrant. The polysulfone UF membranes had a 10-kDa molecular weight cut-off. The retentate collected during the MF step was diluted back to the original weight of the skim milk with UF permeate. The diluted skim retentate was then processed using MF and this constituted the first DF. After the first DF to 3X, the retentate from MF was again diluted with UF permeate and processed (3X) using MF. The UF permeate used for DF contained a low concentration (ca. 0.07%) of SP. Thus, the total SP in the process was that in the skim plus the SP added with the UF permeate. MF plus the two subsequent DF steps removed about 94% of the total SP. The observed SP removal

was close to the expected theoretical value of 96% serum protein for the process.

Key Words: Microfiltration, Diafiltration, Milk

764 Isolation and identification of *Micrococcus* spp from Egyptian soft cheese. A. S. Zahran*, *Minia University*.

Micrococci are the predominant bacteria of milk drawn aseptically from the udder. They were also isolated from different cheese varieties. These bacteria constitute a major portion of the secondary cheese microflora and contribute to its flavour through their proteolytic, lipolytic and esterolytic enzymes activities. Fifty strains of *Micrococcus* spp were isolated from Egyptian soft cheese (Domiat). They were identified into four different species as follows *M. varians*, *M. roseus*, *M. sedentarius* and *M. luteus*. The species most often isolated was *M. varians* as it represents 55% of the total isolates, strain *M. varians* DC6 was very active producer of extracellular proteinase and lipase. Immobilized cell culture is a widely used technique for achieving high volumetric efficiency and sustained productivity from microorganisms. The entrapment of bacterial cells in 2% agar substantially improved their enzyme activity. Immobilized cells produced from 40-50% more enzymes than free cells. The agar entrapment method appeared to have no adverse effects on the activity of the cells. The agar beads were structurally stable over five usage cycles. Synthesis of the extracellular enzymes by *M. varians* DC6 appeared to be inducible as no enzymes were detected in the absence of organic nitrogen.

Key Words: *Micrococcus*, Egyptian Soft Cheese, Immobilized Cells

765 Use of exopolysaccharides producing lactic acid bacteria for the production of buffalo milk dahi (yogurt). N. Pandya*¹, S. Kanawjia¹, and R. Dave², ¹*Dairy Technology Department, National Dairy Research Institute, Karnal, India*, ²*Dairy Science Department, South Dakota State University, Brookings*.

Exopolysaccharides (EPS) produced by lactic acid bacteria (LAB) have generated increasing attention among researchers and considered novel and safe food additives. In this experiment, two EPS⁺ cultures (*Lactococcus lactis* subsp. *lactis* NCDC 191 & mixed thermophilic strains NCDC 260) in combination with standard dahi culture (mixed mesophilic strains NCDC 167, EPS⁻) were studied for their effects on incubation pattern, rheology and sensory properties of the dahi made from buffalo milk standardized at 4.5% fat and 9.5% SNF. Both cultures were inoculated at 2% (v/v) rate in three different ratios (1:1, 2:1 and 3:1 of EPS⁻ and EPS⁺ cultures respectively) and incubated at 27 and 32°C for NCDC 191 and NCDC 260, respectively. It was observed that the rate of drop in pH and rate of increase in titratable acidity declined with increasing proportion of EPS⁺ cultures. Rheology and overall sensory properties were improved with increasing ratio of EPS⁺ culture. However, the improvement was significant ($P < 0.05$) only with NCDC 260, but not with NCDC 191. With the increasing proportion of NCDC 260, the viscosity increased from 0.384 to 0.596 Pa.s., the curd tension increased from 35.52 to 46.60 g, and the syneresis reduced from 1.48 to 0.33 ml per 10 g of dahi. The flavor scores decreased significantly ($P < 0.05$) with increasing ratio of NCDC 191 culture whereas, effect of NCDC 260 culture on flavor scores was not significant ($P < 0.05$). The body and texture scores improved up to 2:1 ratio (NCDC 167: NCDC 260) but at a higher ratio of EPS⁺ culture the dahi developedropy consistency and resulted into decline in sensory scores. The appearance scores were improved for both EPS⁺ cultures. A combination of NCDC 167 and NCDC 260 with (2:1) ratio was suggested for commercial production of dahi.

Key Words: Exopolysaccharides, Buffalo Milk, Dahi

ASAS - Growth and Development II

766 Influence of dietary protein and lactose levels on protein synthesis and translation initiation factor activation in neonatal pigs. J. W. Frank*¹, J. Escobar¹, A. Suryawan¹, H. V. Nguyen¹, C. W. Liu¹, S. R. Kimball², L. S. Jefferson², and T. A. Davis¹, ¹*USDA/ARS Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX*, ²*College of Medicine, The Pennsylvania State University, Hershey*.

Parenteral infusion of insulin (INS) and amino acids increases protein synthesis (PS) and eukaryotic translation initiation factor (eIF) activation in skeletal muscle and liver. Pigs (N = 25; BW = 1.6 kg) were enterally fed isocaloric milk diets with three levels of protein (5, 10, and 15 g/kg/d) and two levels of lactose (11 and 23 g/kg/d) from 1 to 7 d of age. On d 7, pigs were gavage fed after a 4 h fast and blood samples were collected every 30 min for 1.5 h. Pigs were then euthanized and tissues harvested. Daily gain and PS in the longissimus dorsi and gastrocnemius muscles and liver were not influenced by lactose level, but increased with dietary protein and plateaued at the 10 g/kg/d level ($P < 0.01$). Plasma INS was greater in the high lactose fed pigs ($P < 0.01$) and lower in pigs fed the lowest protein diet ($P < 0.001$). Plasma branched-chain amino acids were influenced by dietary protein level ($P < 0.001$). Liver and muscle protein kinase B phosphorylation was greater in the high lactose fed pigs ($P < 0.05$). Liver and muscle ribosomal protein S6 kinase and liver 4E-BP1 phosphorylation increased with dietary protein and plateaued at the 10 g/kg/d level ($P < 0.01$), while muscle 4E-BP1 phosphorylation continued to increase to the highest protein level ($P < 0.001$). The association of eIF4G to eIF4E increased with dietary protein level ($P < 0.05$) and was not influenced by lactose level. The results suggest that growth and PS in neonatal pigs are influenced by dietary protein intake. These changes involve modulation of the availability of eIF4E for eIF4F complex assembly and may be mediated by plasma insulin and amino acid levels. (NIAMS AR 44474, USDA 58-6250-6-001)

Key Words: Pigs, Protein Synthesis, Translation Initiation

767 Infusion of a physiological dose of leucine stimulates muscle protein synthesis in neonatal pigs by enhancing the activity of translation initiation factors. J. Escobar*¹, J. W. Frank¹, S. R. Kimball², A. Suryawan¹, H. V. Nguyen¹, C. W. Liu¹, L. S. Jefferson², and T. A. Davis¹, ¹*USDA/ARS, Children's Nutrition Research Center, Baylor College of Medicine, Houston, TX*, ²*Cellular and Molecular Physiology, College of Medicine, Pennsylvania State University, Hershey*.

In adult rats, skeletal muscle protein synthesis increases in response to pharmacological doses of leucine (Leu) administered orally. The effect of a physiological rise in plasma Leu on skeletal muscle protein synthesis has not been investigated in neonatal pigs, which are highly sensitive to amino acid and insulin stimulation. Thus, 24 crossbred pigs were food-deprived for 12 h and intra-arterially infused with Leu (0 or 400 mmolkg⁻¹h⁻¹). Protein synthesis was measured after 60 or 120 min in liver, and longissimus dorsi and gastrocnemius muscles. Infusion of Leu increased ($P < 0.01$) plasma Leu 2.5- to 3.4-fold while plasma insulin and glucose were unchanged. Infusing Leu for 120 min, but not for 60 min, reduced ($P < 0.05$) plasma essential amino acids levels. Infusing Leu for 60 and 120 min increased ($P < 0.05$) phosphorylation of eukaryotic initiation factor (eIF) 4E binding protein-1 (4E-BP1), ribosomal protein (rp) S6 kinase (S6K1), and rpS6, and decreased the amount of eIF4E associated with its repressor, 4E-BP1, in longissimus dorsi muscle. In liver, phosphorylation of 4E-BP1, S6K1 and rpS6, as well as eIF4E associated with 4E-BP1 were not affected by Leu infusion. Leucine infusion for 60 min increased protein synthesis in longissimus dorsi (38%, $P = 0.04$) and gastrocnemius (67%, $P = 0.005$) muscles, but not in liver ($P = 0.11$). Leucine infusion for 120 min did not increase protein synthesis in skeletal muscle and reduced protein synthesis in liver (25%, $P < 0.01$). Thus, a physiological increase in plasma Leu stimulates protein synthesis in skeletal muscle of neonatal pigs by increasing eIF4E availability for eIF4F assembly. Moreover, this response appears to be insulin-independent, substrate-dependent, and tissue-specific (NIAMS AR 44474, USDA58-6250-6-001).

Key Words: Leucine, Translation Initiation Factors, Protein Synthesis

768 Body protein deposition response following sudden changes in ideal protein intake differs between pig types. H. R. Martínez* and C. F. M. de Lange, *Department of Animal and Poultry Science, University of Guelph, ON, Canada.*

The objective of this study was to evaluate the extent and dynamics of compensatory growth following a period of lysine intake restriction in two pig types. In Exp. 1, 40 Yorkshire barrows (14.4 ± 1.6 BW) were assigned to one of two diets (control, - 50% lysine) and fed restricted at 75% of voluntary daily DE intake according to NRC (1998; % of NRC) from 15 to 35 kg BW. Thereafter, pigs were fed restricted (75% of NRC) or ad libitum diets that were not limiting in ideal protein. In Exp 2, 57 Yorkshire entire male pigs (15.8 ± 0.9 BW) were assigned to one of three diets (control, -30% or - 45% lysine) and fed restricted (90% of NRC) from 15 to 38 kg BW; thereafter they were fed at 90% of NRC diets not limiting in ideal protein. BW gain and body composition (serial slaughter) was monitored for at least 30 days after lysine intake restriction was removed. Lysine intake restrictions reduced growth rate ($P < 0.01$; 533 vs 410 g/d in Exp. 1; 794 vs 672 and 648 g/d in Exp. 2). Based on BW gain, no compensatory growth (CG) occurred in barrows ($P = 0.95$) due to previous lysine intake restriction; there were no interactive effects of feeding regime and previous diet lysine level on BW gain ($P = 0.74$). In entire males at 38 kg BW, lysine intake restriction tended to increase body lipid to protein ratios (L/Pr; 0.83, 0.95, 1.06; SE 0.08, $n = 2$). Entire males showed full CG. The BW gain was inversely related to previous diet lysine levels between 38 and 53 kg (1104, 1152, 1210 g/d; $P < 0.03$) and between 38 and 110 kg BW (1100, 1166, 1180 g/d; $P < 0.01$). Body composition (L/Pr; 1.07, 1.12, 1.12; SE 0.05) and carcass characteristics (backfat 20.0, 20.4, 20.7 mm, SE 1.79; loin area, 4596, 4579, 4557 mm², SE 136; colour; carcass protein/body protein mass, 1.16, 1.19, 1.19, SE 0.06) in entire males at 110 kg BW were not influenced ($P > 0.10$) by diet lysine level between 15 and 38 kg BW. CG is more likely to occur in growing pigs with higher lean tissue growth potentials.

Key Words: Compensatory Growth, Body Composition, Pig Type

769 Human somatotropin is more efficacious than porcine somatotropin in growing pigs. F. R. Dunshie*, *Department of Primary Industries, Werribee, Victoria, Australia.*

While the improvements in productive efficiency in response to daily porcine somatotropin (pST) injection are well documented, there is some evidence that human ST (hST) may be even more efficacious than pST. If the relative differences in efficacy between the two ST's is great enough, then variants of human somatotropin may be worth pursuing as a daily injectable for pigs. Forty two individually-penned crossbred gilts (60.4 kg) were stratified on live weight into 14 blocks and then one pig from each block was then randomly assigned to a treatment group consisting of either 7 doses of pST (0, 1.0, 2.0, 3.0, 4.0, 5.0 and 6.0 mg/day) and 7 doses of hST (0, .2, .4, .6, .8, 1.0 and 1.2 mg/day) for 7 days. The regression equation relating feed conversion ratio (FCR) to dose of pST and hST was described by the following equation (with standard errors in brackets): $FCR = 2.4976 (.0817) - .1279 (.259) \times pST \text{ dose} - .409 (.130) \times hST \text{ dose}$. Thus, the FCR for control animals was 2.50, and decreased by .128 and .409 for every mg/d increase in dose of pST and hST, respectively. Therefore, hST was approximately 3.2x more effective in decreasing FCR than pST. While the effects of ST on plasma urea nitrogen (PUN) could not be as easily explained by regression techniques, both pST and hST significantly ($P < .001$) reduced PUN. Application of pST at 5x the dose of hST was more effective in reducing PUN, indicating that the relative difference in potency was less than 5x. Therefore, it appears that hST is approximately 3x more effective in pigs than pST, at least in the short term.

Key Words: Growth, Swine, Growth Hormone

770 Concentrations of insulin-like growth factors I and II in embryonic fluids of chickens, ducks, and turkeys. D. M. Karcher*¹, J. P. McMurtry², and T. J. Applegate¹, ¹*Animal Sciences, Purdue University, West Lafayette, IN,* ²*USDA/ARS/GBL, Beltsville, MD.*

Insulin-like growth factors (IGF-I, IGF-II) are present in the amniotic fluid of developing mammals and ingestion of the amniotic fluid has been

shown to potentially impact the proper development of the gastrointestinal tract. To investigate IGF-I and II changes in avian embryo fluids, 250 duck eggs, 200 turkey eggs, and 222 chicken eggs were incubated, and the embryos were staged according to Hamburger and Hamiltons classification (1951). Amniotic and allantoic fluid IGF-I and -II concentrations were determined by a chicken radioimmunoassay which has 100% reactivity between all species. When the beak was prominent on the embryo, stage 29, the mean IGF-I concentration (conc.) of the chicken amniotic fluid was 97.9% greater than the mean turkey conc. and 81.5% greater than the mean duck conc. ($P \leq 0.05$). At stage 40, when the external features are complete, the chicken amniotic fluid IGF-I conc. was 34.6% greater in the duck amniotic fluid and 17.5% greater than in turkey amniotic fluid ($P \leq 0.05$). However, at stage 37 and 38 (eye-lids narrow and leg scales appear) the IGF-I conc. in turkey amniotic fluid was 70-80% higher compared to the chicken or duck conc. ($P \leq 0.05$). Within species, amniotic IGF-I conc. were low at stage 29 with maximum conc. occurring at the time of imbibing (stage 42 duck and turkey; stage 44 for chicken). The amniotic IGF-I conc. in the chicken had a cubic relationship ($r^2 = 0.41$; $P = 0.0003$) with a 95% difference ($P \leq 0.05$) between the lowest and highest conc. Duck amniotic IGF-I had a linear relationship ($r^2 = 0.73$; $P < 0.0001$) with a 94% ($P \leq 0.05$) difference observed between highest and lowest conc. The IGF-I conc. in the turkey amniotic fluid followed a similar trend with a quadratic relationship ($r^2 = 0.43$; $P = 0.0006$) and an observed difference in minimum and maximum conc. of 98% ($P \leq 0.05$). Amniotic fluid IGF-II was not significantly ($P > 0.05$) different across species. Overall, the conc. of IGF-I and II varies across and within species.

Key Words: Insulin-Like Growth Factors, Embryonic Fluids, Duck

771 Selection for growth does not alter jejunal glucose absorption and energy metabolism in mice. Y. K. Fan¹, W. J. Croom, Jr.*², I. L. Taylor³, L. R. Daniel², A. R. Bird⁴, B. W. McBride⁵, V. L. Christensen², and E. J. Eisen², ¹*National Chung Hsing University,* ²*North Carolina State University, Raleigh,* ³*Tulane University, New Orleans, LA,* ⁴*CSIRO Health Sciences and Nutrition, Australia,* ⁵*University of Guelph, ON, Canada.*

The present study was designed to investigate the effects of genotype and sodium monensin (NaM) on whole body energetics and jejunal function (JF) using 4 different genetic lines of mice. The lines were M16 (selected for rapid growth), randomly bred controls (ICR) and their reciprocal crosses (M16xICR and ICRxM16). Eight-week-old mice from each line were administered either NaM (20 μ M) or excipient via the drinking water for 14d ($n=6$ mice per cell). Whole-body O₂ consumption was measured on day 11. On day 14, mice were euthanized and the jejunum dissected for measurement of jejunal protein and DNA, total, serosal and mucosal O₂ consumption, jejunal uptake rate and whole jejunal glucose uptake. The apparent energetic efficiency (APEE) of glucose uptake was calculated. M16 mice were larger, had greater feed and water intake and greater body fat %. Selection for growth had no effect on intestinal weight adjusted for fasted body weight, increased SI density (mg/cm) and decreased adjusted SI length ($P < .01$). M16 mice had greater intestinal villus width, crypt depth and enterocyte height ($P < .05$) but decreased villus height/crypt depth ($P < .05$). No changes were noted in serosal or mucosal O₂ consumption. M16 mice had lower jejunal glucose uptake rates, total jejunal glucose absorption adjusted for BW ($P < .01$). APEE of glucose uptake decreased 51% in M16 compared to ICR ($P < .05$). Reciprocal crosses (ICRxM16 vs. M16xICR) had few effects on physiological parameters measured as compared to ICR. NaM decreased feed efficiency (mg gain/g feed) and daily water intake across all lines ($P < .01$) but had no effect on adjusted whole-body O₂ consumption. Jejunal protein/DNA decreased as well as jejunal villus width ($P < .05$) with NaM. Selection for growth resulted in less glucose absorption and efficiency of glucose transport. This supports the existing hypothesis that selection for growth does not inevitably result in a concomitant increase in jejunal function or APEE of nutrient absorption.

Key Words: Genotype, Jejunal Absorption, Monensin

772 Effect of microbial colonisation on activated caspase-3 protein and gene expression in the gnotobiotic pig small intestine. B. P. Willing*, R. H. Siggers, T. W. Shirkey, B. G. Goldade, J. K. Marshall, B. Laarveld, and A. G. Van Kessel, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

Previous gnotobiotic pig experiments have shown dramatic differences in ileal morphology in germ-free (GF) and mono-associated as compared to conventionalized pigs, most prominently characterized by as much as a 2-fold increase in villus length. In three experiments sixteen piglets were derived by caesarian-section, allocated to one of four treatment groups including GF, mono-associated with non-pathogenic *Escherichia coli* (EC) or *Lactobacillus fermentum* (LF) or conventionalized with sow feces (CV) and reared to 13 (exp. 1) or 14 (exp. 2&3) d of age. In experiment 3 the LF group was contaminated with *Klebsiella pneumoniae* making it di-associated (LFKP). In experiment 1, whole intestinal tissue was collected at 75% of the small intestine (SI) length. In experiments 2 and 3, villus tip epithelial cells were harvested from 80 cm lengths of SI with 1.5mM EDTA using the distended sac method. To characterize the morphological differences in relation to apoptosis, activated caspase-3 protein and caspase-3 gene expression were measured by Western blot and quantitative PCR (qPCR). Activated caspase-3 protein was detectable in whole intestinal tissue in CV animals only. In the same tissue, caspase-3 mRNA abundance was similar among CV, LF and EC but reduced 1.8 fold in GF ($P < 0.05$). In villus tip cells there was a slight trend for reduced caspase-3 expression in GF, EC, LF and LFKP treatment groups relative to CV. Results indicate that analysis of both transcript and activated protein abundance can yield complementary information regarding apoptotic activity. Apoptotic activity appeared lower in GF and mono-associated pigs however, relative differences in gene expression in whole tissues versus villus tip epithelial cells suggest that markedly increased cellular infiltration of *lamina propria* and/or development of peyers patches in CV pigs may contribute significantly to apoptotic activity observed when whole intestinal tissue is analyzed.

Key Words: Gnotobiotic, Pig, Caspase-3

773 The effect of microbial colonisation on disaccharidase activity in the gnotobiotic pig. L. M. Williams, B. P. Willing*, R. H. Siggers, T. W. Shirkey, B. G. Goldade, J. K. Marshall, and A. G. Van Kessel, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

In previous gnotobiotic pig research we have found that germ free and mono-associated pigs had up to 2-fold longer villi than conventional pigs, chiefly in the distal small intestine (SI). Enterocytes along the distal villi of mono-associated and germ free pigs contained large and apparently empty vacuoles. To characterize the effect of specific bacteria on digestive function in relation to intestinal morphology, brush border disaccharidase activity was determined in SI segments collected from pigs in two separate experiments. Each experiment included 16 pigs derived by caesarian-section and assigned to, germ free (GF), mono-associated with non-pathogenic *Escherichia coli* (EC), mono-associated with *Lactobacillus fermentum* (LF) or conventionalised with sow feces (CV), treatment groups. In experiment 2 the germ free group was contaminated with a *Staphylococcus* sp. (ST). Pigs were fed a 2:1, Similac[®].water, (v/v) mixture *ad libitum* and killed at 13 days of age. Lactase, sucrase and maltase activities were determined per unit protein, DNA and wet tissue weight, for segments collected at 25 and 75% of SI length. The effect of treatment and SI location on specific disaccharidase activities were similar whether reported per unit protein, DNA or wet tissue weight, were always higher in the proximal SI, were similar among GF and monoassociated pigs and were always lowest in CV pigs. Lactase activity was highest in all treatment groups at both locations, however, this was most notable (2-fold higher versus maltase and sucrase) in distal SI of mono-associated and GF pigs. In conclusion the vacuolated enterocytes, associated with markedly elongated villi observed in the distal small intestine, of GF and monoassociated pigs demonstrated significant disaccharidase activity, however the pattern of activity was consistent with the very early postnatal period and slow enterocyte turnover.

Key Words: Gnotobiotic, Disaccharidase, Pig

774 Characterization of specific gene expression following differentiation of bovine stromal-vascular cells into adipocytes. M. J. Herson*¹, J. W. Ross², D. Stein², L. McBeth², R. D. Geisert², U. Desilva², C. R. Krebbiel², and J. R. Malayer², ¹University of Florida, Gainesville, ²Oklahoma State University, Stillwater.

The objectives of the present experiment were to 1) determine if gene expression differs during adipocyte differentiation of bovine stromal-vascular (SV) cells from different adipose depots and 2) determine similarity of differentiation of cultured bovine SV to the mouse 3T3-L1 cell line. Bovine SV cells were isolated from s.c., i.m., and kidney-pelvic-heart (KPH) adipose depots, cultured to confluence, then stimulated to differentiate for 0, 12, 24, 48, and 72 h. Expression of bovine specific peroxisome proliferators-activated receptor- γ (PPAR γ), stearoyl CoA desaturase 1 (SCD-1), lipoprotein lipase (LPL), fatty acid synthase (FAS), and acyl-CoA synthetase (ACS) mRNA was determined using quantitative RT-PCR. 18S ribosomal RNA was utilized to standardize RNA loading. Relative quantitative mRNA expression was evaluated using the comparative CT method. PPAR γ gene expression of s.c. adipocytes exhibited a 7.5-fold increase from 12 to 48 h compared to 3-fold and 3.8-fold increase in i.m. and KPH from 6 to 12 or 24 h (D x T, $P < 0.001$). SCD-1 gene expression in s.c. increased 7-fold from 0 to 72 h compared to 1.8 and 2.7-fold increases for i.m. or KPH (D x T, $P = 0.04$). Gene expression of LPL in s.c. increased 8-fold by 48 h compared to 2- and 3-fold increases in KPH and i.m. (D x T, $P < 0.001$). FAS (D x T, $P < 0.001$) and ACS (D x T, $P = 0.002$) gene expression decreased 4.9 and 4.6-fold in i.m. and 3.4 and 3.6-fold in KPH, s.c. gene expressions decreased 1.7 and 1.2-fold, respectively. 3T3-L1 PPAR γ gene expression was minimal at 6 h and was 16 and 223-fold greater ($P < 0.001$) at 24 and 48 h. Differences in gene expression exist among bovine adipose depots. A similarity in response time but not magnitude of PPAR γ in bovine s.c. and 3T3-L1 cells indicates that bovine SV cells are an acceptable model for adipocyte differentiation. Differences between mouse and bovine cells and among depots indicate the physiological importance of adipocyte specificity.

Key Words: Adipose, Bovine, Gene Expression

775 Dexamethasone downregulates glucocorticoid receptor expression in cultured bovine preadipocytes. G. Ortiz-Colón*, A. C. Grant, J. L. Burton, M. E. Doumit, and D. D. Buskirk, *Department of Animal Science, Michigan State University, East Lansing.*

Bovine adipose tissue from different depots have been shown to have distinct physiological responses to glucocorticoids. The objectives of this study were to determine if the glucocorticoid receptor (GR) was expressed in cultured preadipocytes isolated from bovine adipose tissues, and to evaluate the effect of dexamethasone treatment upon the GR abundance. Preadipocytes were isolated from intramuscular (i.m.), perirenal (p.r.) and subcutaneous (s.c.) adipose tissues of an Angus steer (556 Kg, 13.5 mo. old), propagated in culture, and seeded in 35 mm-diameter dishes at a density of 2,600 cells/cm². Preadipocytes were fed every other day with growth media: Dulbeccos modified Eagles medium (DMEM) containing 10% fetal bovine serum. After 8 days, cells were exposed to control growth media, or growth media containing .25 μ M dexamethasone for 48 h. The cells were then solubilized by the addition of hot (95°C) electrophoresis sample buffer. Proteins were electrophoretically separated using 10% polyacrylamide gels and transferred onto polyvinylidene fluoride microporous membranes. The membranes were incubated with an antibody against GR and subsequently exposed to a secondary antibody conjugated to alkaline phosphatase. Immuno-reactive bands were visualized upon addition of substrate. The GR was detected as a specific 97 kDa band in the cultured preadipocytes from the three adipose tissues. An antibody against β -actin was used as an internal control. Bands were quantified using Quantity One software (Bio-Rad) and data were analyzed by the GLM procedure of SAS. Glucocorticoid receptor abundance was reduced by dexamethasone exposure in i.m. (7.0%), s.c. (52.7%), and p.r. (35.6%) preadipocytes ($P < .03$). It can be concluded that GR was expressed in these cultured preadipocytes isolated from bovine s.c., p.r., and i.m. adipose tissue and that the synthetic glucocorticoid dexamethasone decreased GR abundance.

Key Words: Bovine, Preadipocytes, Glucocorticoid Receptor

776 Dietary coconut oil and conjugated linoleic acid reduce body fat in mice. K. M. Hargrave* and J. L. Miner, *University of Nebraska, Lincoln*.

Mice raised on a coconut oil (CO)-containing diet for 6 wk prior to the addition of conjugated linoleic acid (CLA) are more sensitive to CLA-induced body fat loss than mice raised on a soy oil (SO)-containing diet. Coconut oil is deficient in essential fatty acids. However the addition of linoleic acid to a CO-containing diet did not alter the enhanced sensitivity to CLA. The objective of this study was to determine if CO enhances sensitivity of mice to CLA-induced body fat loss independent of an essential fatty acid deficiency. Eighty male mice (12 wk old) were fed a purified SO-containing diet for a 1 wk adaptation. Mice were then blocked by body weight and randomly allotted to a treatment diet. Diets were arranged in a 2 x 2 factorial design with SO vs CO and 0 vs 0.5% CLA isomers. Mice were fed for 2 wk and body weight and feed intake were measured weekly. Mice were then killed and body fat and lean mass were determined by dual x-ray densitometry and fat pads and livers were weighed and collected. DNA fragmentation, indicative of apoptosis, was measured in one epididymal fat pad and is expressed as (fragmented DNA/total DNA)*100. CO-fed mice consumed more ($P < 0.05$) feed than SO-fed mice during both weeks of treatment but weighed less ($P < 0.05$) in the second wk. CO+CLA mice consumed less feed than CO mice but SO and SO+CLA mice did not differ in feed intake (CO x CLA interaction, $P < 0.05$). Both CO and CLA reduced ($P < 0.001$) body fat and fat pad weights. There was a trend for a CO x CLA interaction ($P = 0.06$) as CO+CLA mice were leaner than SO+CLA (11.94% vs 15.48% body fat, respectively). There were no differences in lean mass. CLA increased ($P < 0.01$) liver weight. There were no differences in DNA fragmentation but CLA did increase ($P < 0.001$) total DNA content of the fat pad. In summary both CO and CLA reduced body fat with a trend for an interaction. Therefore, feeding CO for a short time appears to increase the sensitivity of mice to CLA-induced body fat loss similar to a longer feeding period. This indicates that CO increases CLA-induced body fat loss in an essential fatty acid deficiency-independent manner.

Key Words: Conjugated Linoleic Acid, Coconut Oil, Body Fat

777 Subcutaneous and abdominal fatty acid composition and CLA profiles in grain finished steers. L. H. Baumgard*¹, S. R. Sanders¹, O. B. Mendivil¹, J. K. Kay¹, J. A. Marchello¹, P. Delmonte², J. M. Griinari³, and M. P. Yurawecz², ¹The University of Arizona, Tucson, ²U.S. Food and Drug Administration, Washington, DC, ³University of Helsinki, Finland.

Subcutaneous (SQ) and abdominal (AB) fat was collected 24 h after harvest from non-implanted Hereford steers (n=3) fed a high concentrate (80%), low forage (20%) finishing diet for 90 d. SQ and AB fatty acid (FA) composition was determined via gas chromatography, and the complete CLA profile (15 isomers) was characterized by triple-column silver-ion high performance liquid chromatography (Ag⁺-HPLC). Levels of total *trans*-18:1 was higher ($P < 0.01$) in AB than SQ (2.37 vs. 1.56%) and the content of *trans*-6,7,8, *trans*-9, *trans*-10, *trans*-11 and *trans*-12 18:1 was 73, 14, 23, 62 and 82% higher ($P < 0.04$), respectively, in AB compared to SQ. Conversely, SQ had a higher ($P < 0.02$) content of unsaturated FA (51 vs. 37%), enhanced CLA levels (0.56 vs. 0.35%) and an increased Δ^9 -desaturase index (47 vs. 30) compared to AB. *cis*-9, *trans*-11 and *trans*-7, *cis*-9 CLA were the first and second most predominant CLA isomers, respectively, in both depots and were higher in SQ compared to AB (69 vs. 59% and 13 vs. 9% of total CLA, respectively). *trans*-10, *cis*-12 CLA was the third and seventh most abundant CLA isomer in SQ and AB depots respectively, but levels did not differ between depots (3.3% of total CLA). *trans*-11, *trans*-13 and *trans*-9, *trans*-11 CLA were the third and fourth most predominant CLA isomers in the AB depot and were higher compared to SQ (5.8 vs 1.5% and 4.9 vs. 2.5% of total CLA, respectively). When adipose depots were combined, the content of total CLA and both the *cis*-9, *trans*-11 and *trans*-7, *cis*-9 CLA isomer (products of Δ^9 -desaturase) were highly correlated with the Δ^9 -desaturase index ($R^2 = 0.97, 0.85$ and 0.81 , respectively). These data indicate marked differences in fatty acid composition including CLA profiles between SQ and AB depots, and suggests the Δ^9 -desaturase system is responsible for *cis*-9, *trans*-11 and *trans*-7, *cis*-9 CLA being the predominant CLA isomers in beef adipose tissue.

Key Words: Beef, CLA, Adipose Depot

Lactation Biology: Biology of Lactation

778 Exogenous porcine prolactin stimulates mammary development in prepubertal gilts. C. Farmer* and M.-F. Palin, *Dairy and Swine R & D Centre, Agriculture and Agri-Food Canada, Lennoxville, QC, Canada*.

The impact of injecting gilts with porcine prolactin (pPRL) in the prepubertal period on mammogenesis was investigated. Crossbred gilts received sc injections of saline (controls; n = 12), 2 mg of pPRL (4PRL; n = 12) or 4 mg of pPRL (8PRL; n = 12) twice daily for a period of 28 d, starting at 75.1 ± 0.5 kg BW. Injections of saline or pPRL were given at 0730 and 1530. Jugular blood samples were collected from all gilts the morning before the first injection, as well as 14 and 28 d later. These samples were assayed for PRL and insulin-like growth factor-I (IGF-I). Gilts were slaughtered on the 28th day of treatment and mammary glands were collected for dissection of parenchymal and extraparenchymal tissues, and for determination of DNA, dry matter, protein and fat contents. Treatments did not alter ($P > 0.1$) IGF-I concentrations but concentrations of PRL at slaughter were greater ($P < 0.01$) in both 4PRL and 8PRL compared to controls, while at mid-treatment, they were greater ($P < 0.05$) only in 8PRL gilts. Parenchymal tissue weight increased with exogenous pPRL (199.8, 434.4 and 364.1 ± 28.4 g for controls, 4PRL and 8 PRL, respectively; $P < 0.001$) and DNA concentrations were greater in pPRL-treated gilts (2.3, 6.0 and 6.2 ± 0.3 mg/g for controls, 4PRL and 8PRL, respectively; $P < 0.001$). The percentages of protein and dry matter in parenchyma increased ($P < 0.001$) while that of fat ($P < 0.001$) and the protein to DNA ratio ($P < 0.05$) decreased with exogenous pPRL. Treatment differences were always observed between the 4 mg dose and the controls, and no further differences were seen when increasing the dose to 8 mg daily. Extraparenchymal tissue weight and total parenchymal fat were unaltered by treatments ($P > 0.1$). It is apparent that pPRL can stimulate mammogenesis in prepubertal gilts through hyperplasia. It would be of great interest to determine if this favorable effect translates into greater milk yield dur-

ing subsequent lactations. (Sincere thanks to Monsanto for supplying the pPRL).

Key Words: Mammary Gland Development, Prolactin, Gilts

779 Gene expression profiling of bovine mammary epithelial cells in response to prolactin and extracellular matrix. L. Rowley*¹, D. Baird², T. Wilson³, J. Whitley¹, C. Berends¹, M. Wells¹, and M. Goddard¹, ¹Primary Industries Research Victoria, Attwood, Australia, ²AgResearch, Lincoln, New Zealand, ³AgResearch Molecular Biology Unit, University of Otago, Dunedin, New Zealand.

Dairy farming is a financially important agricultural resource to Australia and further economic gains could be realised through improved milk yield or composition. In order to manipulate milk production however, we need to more fully understand the functional regulation of milk protein synthesis and secretion in the bovine mammary gland. In order to identify regulatory mechanisms involved in the differentiation of the mammary gland, primary mammary epithelial cells were cultured in the presence and absence of both prolactin (1 μ g/mL) and extracellular matrix. Culture medium was analysed by Western blotting to evaluate milk protein synthesis and secretion. RNA was isolated from cells in culture to assess gene expression using cDNA microarrays containing 23k bovine expressed sequence tags. Microarray data was statistically analysed by mixed model analysis using REML (restricted maximum likelihood). When cultured in the presence of extracellular matrix, mammary epithelial cells were able to assume three-dimensional spherical structures similar to mammary secretory alveoli in vivo. Western blot analysis showed that the secretion of the milk proteins, β -lactoglobulin, α_{S1} - and β -casein was greatly upregulated in the presence of both prolactin and extracellular matrix. Microarray analysis has identified genes

that are differentially regulated by prolactin and extracellular matrix. Further examination of differentially regulated genes may enable elucidation of the specific regulatory mechanisms and ultimately, control over the production and composition of milk.

Key Words: Microarray, Prolactin, Extracellular Matrix

780 Microarray analysis of prolactin signalling in the bovine mammary gland during lactogenesis. M. Wells^{*1}, C. Prosser², D. Baird³, T. Wilson⁴, M. Auld⁵, J. C. Whitley¹, J. K. Lee¹, J. Argento¹, and M. Goddard¹, ¹Primary Industries Research Victoria, Attwood, Australia, ²AgResearch, Ruakura, New Zealand, ³AgResearch, Lincoln, New Zealand, ⁴AgResearch Molecular Biology Unit, University of Otago, Dunedin, New Zealand, ⁵Primary Industries Research Victoria, Ellinbank, Australia.

The Australia-New Zealand Dairy Genomics Program is a collaborative research project, which aims to improve milk production, alter milk composition and identify novel products. In order to achieve these aims, however, it is necessary to increase our understanding of regulatory mechanisms in the bovine mammary gland. The objective of this trial was to identify genes within the mammary gland that are prolactin responsive, and which therefore regulate lactogenesis and milk yield around calving. Bromocriptine, which blocks the peri-parturient surge in prolactin in dairy cattle, was administered to Friesian cows (5 mg/100kg body weight; n=5) every 2 days, beginning 12 days before expected calving and ending at calving. Controls (n=5) received saline-only injections. At 72 hours post-partum, animals were slaughtered and mammary tissue was collected for RNA isolation. Analysis of gene expression was performed using cDNA microarrays comprising 23,000 bovine expressed sequence tags (ESTs), with a mixed model statistical analysis using restricted maximum likelihood to estimate the variance components. Serum prolactin levels in treated animals decreased by ~90% relative to control cows. In the 3 days following calving, bromocriptine-treated cows demonstrated a 40% reduction in milk yield. Analysis of milk composition showed decreased concentrations of α -lactalbumin, β - and κ -casein, whilst β -lactoglobulin and serum albumin increased. These results are consistent with a delay in the onset of lactogenesis due to the blocking of prolactin secretion by bromocriptine. Microarray analysis has identified 1254 differentially regulated ESTs (827 down-regulated and 427 up-regulated) in the mammary gland of bromocriptine-treated cows relative to control cows. Further investigation of differentially regulated genes will improve our understanding of the role of prolactin in lactogenesis in the dairy cow, and may provide opportunities for the manipulation of milk production.

Key Words: Microarray, Lactogenesis, Bromocriptine

781 Expression of prolactin responsive genes following experimental manipulation of the prolactin axis during early lactation in dairy cows. E. H. Wall^{*1}, H. M. Crawford², G. E. Dahl², and T. B. McFadden¹, ¹University of Vermont, Burlington, ²University of Illinois, Urbana.

Increased milking frequency during early lactation results in a persistent increase in milk yield, however the mechanisms underlying this effect are unknown. Frequent milking elicits additional episodes of milking induced prolactin (PRL) secretion as well as more frequent emptying of the gland. Our objective was to distinguish the relative contributions of each of these factors. We hypothesized that augmented PRL signaling mediates the response to increased milking frequency in early lactation. Hence, we proposed that treating cows milked 2X/d with exogenous prolactin would provoke responses similar to those of cows milked 4X/d. Conversely, blockade of milking-induced PRL release by injection of bromocriptine in cows milked 4X/d would result in similar responses as those of cows milked 2X/d. Twenty multiparous Holstein cows received 1 of 4 treatments from d 2 to 21 postpartum: 2X, 4X, 2X+PRL, or 4X+bromocriptine. Exogenous PRL or bromocriptine was administered coincident with the 3rd and 4th milkings. Mammary biopsies were obtained at 7 DIM (n=5 cows/treatment), and rates of [³H]-thymidine incorporation into DNA in vitro were measured. Expression of mRNA for PRL receptor (long form), α -lactalbumin and suppressor of cytokine signaling-3 (SOCS-3) was measured by real time RT-PCR as indices of PRL signaling. Data were analyzed using the GLM procedure of SAS. Expression of α -lactalbumin mRNA was greater (P<.06) in 2X+PRL cows compared to the other groups, which were similar. Abundance of PRL receptor mRNA was similar among 2X, 4X+bromocriptine, and

4X treated cows, but was reduced in 2X+PRL cows compared to the 4X group (P<.05). 2X cows expressed higher levels of SOCS-3 mRNA than all other treatment groups (P<.06). There was no treatment effect on [³H]-thymidine incorporation into DNA. The differences in expression of PRL-responsive genes suggest interactive effects of PRL and milk removal in regulation of mammary responses.

Key Words: SOCS, Milking Frequency, Prolactin

782 Effects of 21-day short day photoperiod (SDPP) during the dry period on prolactin (PRL) concentrations, lymphocyte PRL receptor (PRL-R) mRNA, and general health of dairy cows. E. D. Reid^{*1}, T. L. Auchtung¹, D. E. Morin¹, T. B. McFadden², and G. E. Dahl¹, ¹University of Illinois, Urbana, ²University of Vermont, Burlington.

Manipulation of photoperiod during the dry period alters subsequent production and cellular immune function in cattle. Specifically, SDPP improves health and milk yield when compared with long day photoperiod (LDPP), likely via increased sensitivity to PRL. Prolactin and PRL-R are responsive to photoperiod and appear to be linked with immune function. However, the minimum duration of SDPP exposure necessary to produce these beneficial effects is unknown. The objective of this study was to determine the effect of 21 d of SDPP at the end of the dry period on PRL concentration, expression of lymphocyte PRL-R mRNA, and general health. Holstein cows (n = 32) were assigned randomly to one of four dry period treatments: LDPP (16 h light: 8 h darkness), SDPP (8 h light: 16 h darkness), AMB (natural lighting schedule during dry period), and SD21 (AMB until 21 d prepartum then SDPP). After parturition, cows were exposed to natural photoperiod. General health was monitored weekly throughout the dry period. Blood was collected at dry off and every 2 wk until 21 d prepartum, at which time sampling occurred weekly until calving. Concentrations of PRL were measured via RIA and expression of PRL-R mRNA in lymphocytes was measured using real-time PCR. There was no difference in PRL concentrations or PRL-R expression among the groups at dry off but by d 28, LDPP had higher (P < 0.05) PRL concentrations than AMB, SDPP or SD21. Prolactin did not differ among the AMB, SDPP, and SD21 groups during the dry period. Expression of PRL-R was higher (P < 0.05) in SDPP cows at d 28 than LDPP, SD21, or AMB, but not different (P > 0.10) between SDPP and SD21 a week prior to calving, after SD21 animals were switched from ambient photoperiod to SDPP. In conclusion, there is an inverse relationship between PRL concentrations and PRL-R mRNA expression in lymphocytes in LDPP and both SDPP and SD21 animals during the short day treatment.

Key Words: Cattle, Photoperiod, Immune Function

783 Exposure to long day photoperiod during the dry period increases mammary gland expression of suppressors of cytokine signaling in dairy cows. E. H. Wall^{*1}, T. L. Auchtung², G. E. Dahl², and T. B. McFadden¹, ¹University of Vermont, Burlington, ²University of Illinois, Urbana.

The mechanism by which short day photoperiod (SDPP; 8h light:16h dark) during the dry period enhances lactational performance in the subsequent lactation is unknown. Cows exposed to SDPP have lower circulating PRL and higher expression of PRL receptor in the mammary gland, whereas long day photoperiod (LDPP; 16h light:8h dark) elicits the reverse. Suppressors of cytokine signaling (SOCS) are induced by cytokines such as PRL and interferon- γ (IFN- γ) and act in a negative feedback manner, inhibiting signaling of such cytokines. We hypothesized that altered expression of SOCS as a result of different daylength modulates mammary sensitivity to circulating PRL during the dry period. Multiparous Holstein cows were dried off 62 days before calving and assigned to LDPP or SDPP during the dry period. After calving, all cows were exposed to ambient photoperiod. Mammary biopsies were obtained at -40, -20, -7 and +7 days relative to calving (n=6 cows/treatment), and mRNA expression for SOCS-2, -3, cytokine inducible SH-2 protein (CIS) and IFN- γ receptor was assessed by real time RT-PCR. Data were analyzed using the mixed procedure of SAS. Expression of SOCS-2 and CIS was low during the dry period, then increased in lactation (P<.05). Higher expression of both CIS (P<.05) and SOCS-2 (P<.09) mRNA was observed in LDPP cows relative to SDPP cows at 20d. CIS expression was also higher at +7d in LDPP cows compared to SDPP cows (P<.01). SOCS-3 and IFN- γ receptor

expression increased from 40d to 7d ($P < .05$) and remained high in lactation for both treatments. These data indicate that cows exposed to LDPP during the dry period experience higher SOCS expression, which may impair PRL induced mammary growth and lead to inferior milk production in the subsequent lactation. The increase in mammary SOCS expression from pregnancy into lactation implies a functional role for SOCS in bovine mammary gland during lactogenesis.

Key Words: SOCS, Photoperiod, Mammary Gland

784 The effects of a 21-day short day photoperiod treatment during the dry period on dry matter intake and subsequent milk production in cows. E. D. Reid*¹, R. L. Wallace¹, T. B. McFadden², and G. E. Dahl¹, ¹University of Illinois, Urbana, ²University of Vermont, Burlington.

The ability to increase milk production by altering day length is a practical management technique in the dairy industry. Long day photoperiod treatment (16 h light:8 h dark, LDPP) during lactation increases milk production in lactating cows. Short day photoperiod treatment (8 h light:16 h dark, SDPP) during the traditional 60 d dry period increases milk production in the subsequent lactation. The purpose of this study was to determine if the effects of SDPP during the dry period could be observed with a 21 d treatment, that could be implemented at the beginning of the transition period and reduce the amount of time animals spend in an enclosed facility. Thirty-one mature Holstein cows were assigned randomly to one of four dry period treatments: LDPP, SDPP, AMB (followed natural lighting schedule during dry period), and SD21 (AMB until 21 d prepartum followed by SDPP). After parturition, animals were exposed to natural lighting treatment during lactation. Milk samples were collected biweekly for 60 d and monthly thereafter. Dry matter intake (DMI) during the dry period was monitored daily. Statistical analysis was performed using a repeated measures model with photoperiodic treatment as the main effect and time as the repeated measure. Multiple comparison tests were conducted to determine significant differences between treatments. Mean SDPP DMI during the dry period was significantly greater than LDPP and AMB ($P < 0.05$), whereas SD21 DMI was intermediate. Mean milk production was higher in SDPP animals ($P < 0.05$), whereas LDPP, AMB, and SD21 were similar over the initial 60 d collection period. Of interest, SDPP, AMB, and SD21 animals display increased persistency when compared with LDPP, suggesting a beneficial effect on milk production through the entire lactation. We conclude that relative to LDPP, SD21 improves DMI during the dry period and increases subsequent lactational persistency.

Key Words: Cattle, Photoperiod, Milk

785 Evidence that prolactin (PRL) mediates effects of milking frequency in early lactation. H. M. Crawford*¹, T. L. Auchtung¹, E. H. Wall², T. B. McFadden², and G. E. Dahl¹, ¹University of Illinois, Urbana, ²University of Vermont, Burlington.

Increasing milking frequency during the first 21 d of lactation results in a persistent increase in milk yield that continues after treatment has ceased. We hypothesized that greater milking frequency increases the number of PRL surges to in turn drive more extensive mammary cell differentiation. To test if PRL surge number was critical to milk yield responses, we assigned 47 mature cows to one of four treatments at calving: 2X (milked twice/d), 4X (milked four times/d), 2X+PRL (2X and PRL injections twice/d), and 4X+Bro (4X and bromocriptine to block two PRL surges/d). Treatments were given from d 2 to 21 postpartum; at d 22 treatments ended and all cows were milked 2X. Blood samples were collected weekly postpartum. Dry matter intake (DMI) was recorded from d 1 to 42 postpartum and milk samples taken weekly. Cows were divided into 2 groups due to season of calving; group 1 consisted of 2X, 4X, and 2X+PRL treatments, and group 2 consisted of 2X, 4X, and 4X+Bro treatments. Basal PRL concentration for d 4 2X+PRL cows was greater than 4X cows ($P < .09$). Basal PRL concentration for d 14 2X cows was higher than 4X+Bro cows ($P < .12$). Energy corrected milk (ECM) was analyzed from week 1 to 6 postpartum. Average daily ECM for the 6 wks for group 1 were 40.5, 45.7, and 46.9 kg/d for 2X, 4X and 2X+PRL. 2X+PRL cows had greater average daily ECM than 2X cows ($P < .11$). Group 2 average ECM for the 6 wks were 51.4, 51.5, and 49.1 kg/d for 2X, 4X and 4X+Bro. For group 1, 4X cows milk yield was greatest for wk 1 ($P < .05$), and greater than 2X for wk 3 ($P < .02$). 2X+PRL cows milk yield was greater than 2X cows for week 3 ($P < .11$) and than 2X and 4X cows for weeks 5 and 6 ($P < .15$). For group 2, 4X

cows milk yield was greater than 2X and 4X+Bro at week 4 ($P < .06$). In group 1 DMI was not different among treatments. In group 2 DMI was greater for 4X+Bro cows than 4X cows ($P < .09$). In summary, increasing PRL pulsatility in early lactation increased ECM similar to the effect of 4X milking.

Key Words: Cattle, Frequent Milking, Prolactin

786 Impact of increased milking frequency in early lactation in multiparous dairy cows. M. J. VanBaale*¹, D. Ledwith², J. M. Thompson³, R. J. Collier¹, and L. H. Baumgard¹, ¹The University of Arizona, Tucson, ²Stotz Dairy, Buckeye, AZ, ³California State Polytechnic University, San Luis Obispo.

Although frequently recommended and occasionally practiced on dairy farms, the effects of increased milking frequency (IMF) on production parameters are poorly understood. Two hundred multiparous cows were randomly assigned to one of five milking frequency treatments at parturition to investigate IMF (6X vs. 3X) effects during early lactation and subsequent milk yield persistency with or without bST. Treatments were 6X milking for 0 (control; milked 3X) or the first 7, 14, 21 DIM (all 4 treatments initiated bST at 63 DIM), or 6X for the first 21 DIM (no bST administration throughout the entire lactation). Cows were housed in a dry lot facility under a thermal neutral environment throughout the study. Individual milk yields were collected daily and milk components were obtained monthly. All cows were body condition scored at parturition and every four wks thereafter. Blood was collected from the coccygeal vein at parturition and weekly for 5 wks thereafter using a subset of cows ($n=15$ /trt from control and the cows assigned to the 21 d 6X treatment with bST). Data reported here in were analyzed through 63 DIM (prior to bST administration). Milk yield tended ($P = 0.07$) to differ between treatments but effects were small (41.2, 39.8, 41.5, 39.1, and 41.0 kg/d, respectively). No overall treatment effects ($P > 0.20$) were observed for milk fat and protein percentages (3.80 and 2.80) nor SCC (220). Treatments did not alter ($P > 0.07$) overall BCS (3.57) or circulating plasma NEFA levels ($P > 0.74$; 467 $\mu\text{eq/l}$). Data suggest that IMF (6X vs. 3X) immediately post partum does not improve milk yield during the first 9 wks of lactation in multiparous cows milked 6X for 7, 14, or 21 d. However, IMF effects (with and without bST) on future milk yield and lactation persistency are currently not known.

Key Words: Increased Milking Frequency, Early Lactation, Dairy Cows

787 Effects of milking frequency during early lactation on performance and health of dairy cows. J. Fernandez*¹, C. M. Ryan, D. M. Galton, and T. R. Overton, Cornell University, Ithaca, NY.

Holstein cows ($n=105$) entering second or greater lactation were used to determine the lactational and health responses to increased milking frequency (IMF) during early lactation. At parturition, cows were assigned to either a control (twice-daily milking during the entire lactation at 12-h intervals; 2X) or IMF (four times per day milking at 5 to 7-h intervals from d 1 through 21 postpartum, then twice daily at 12-h intervals for the rest of lactation; 4X) treatment. Milk yield and composition data were collected for the first 9 monthly test days. Cows milked 4X during the first 21 d of lactation tended to have increased milk yield during the first 9 monthly test days (35.5 vs. 33.9 kg/d; $P < 0.12$) compared to the cows milked 2X. Milking cows 4X during the first 21 d of lactation tended to decrease milk fat percentage (3.37 vs. 3.52%; $P < 0.07$) and decreased milk true protein percentage (2.83 vs. 2.93%; $P < 0.02$) such that yields of milk fat (1.20 vs. 1.20 kg/d), 3.5% fat-corrected milk (35.2 vs. 34.2 kg/d) and true protein (1.01 vs. 1.00 kg/d) during the first 9 monthly test days were not affected ($P > 0.15$) by treatment. Concentrations of NEFA (707 vs. 639 $\mu\text{Eq/l}$) in plasma collected during d 5 to 20 postpartum were not affected ($P > 0.15$) by treatment; however, concentrations of plasma β -hydroxybutyrate tended to be increased in the cows milked 4X (12.1 vs. 10.1 mg/dl; $P < 0.14$). Overall, milk yield responses to IMF during early lactation were modest, and yields of fat and protein in milk were not affected by IMF during early lactation in this experiment.

Key Words: Dairy Cow, Milking Frequency

788 Effects of continuous milking, bST and early-lactation milking frequency on mammogenesis, milk yield and composition in primiparous cows. A. C. Fitzgerald*, E. L. Annen, P. C. Gentry, L. H. Baumgard, and R. J. Collier, *University of Arizona, Tucson*.

Continuous milking (CM) of bST-supplemented primiparous cows results in production losses of 20 to 25%, suggesting mammary growth was inhibited. We hypothesized continuous (throughout late gestation and early lactation) bST supplementation and/or early-lactation increased milking frequency (IMF) would alleviate production losses in CM glands through improved mammary epithelial cell (MEC) functionality and proliferation. Primiparous cows were randomly assigned to either continuous bST (+bST; n = 4) or no bST (-bST; n = 4) treatment throughout the experiment. Within each animal, udder halves were randomly assigned to either CM or a 60-d dry period (CTL) treatment. CTL halves were dried -60 d relative to expected parturition date. CM glands were milked twice daily until parturition or spontaneous dry-off. At parturition all cows were milked four times daily (4X) until 30 d postpartum. Time points for mammary biopsies averaged -19, -7, +2, +7, and +20 d relative to parturition. Average d dry for CTL glands was 59.5 and 49.3 d for 4X+bST and 4X-bST treatments. Due to spontaneous dry-off, CM halves were dry for an average of 1.0 and 13.5 d for 4X+bST and 4X-bST treatments. Prepartum half-udder milk yield was greater (P < 0.01) in +bST cows than -bST cows (11.7 vs. 9.2 kg/d). Postpartum milk yield was reduced (P < 0.01) in CM udder halves regardless of bST treatment (15.0 vs. 25.0 kg/d; CM vs. CTL). Milk composition (fat, protein, SCC linear score) was not affected by CM or bST. MEC proliferation (Ki67 antigen index) was greater (P < 0.01) in CTL glands at d -7 (6.2 vs. 3.4%, CTL vs. CM), but was not affected at d -19, +2, +7, or +20. MEC proliferation was unaffected by bST. Decreased milk yield in CM halves was not overcome by bST in primiparous cows milked 4X. Further, MEC proliferation was reduced in CM halves near parturition (-7 d).

Key Words: Continuous Milking, bST, Mammary Cell Proliferation

789 The anticancer effects of vaccenic acid in milk fat are due to its conversion to conjugated linoleic acid via Δ^9 -desaturase. A. L. Lock*¹, B. A. Corl¹, D. E. Bauman¹, D. M. Barbano¹, and C. Ip², ¹*Cornell University, Ithaca, NY*, ²*Roswell Park Cancer Institute, Buffalo, NY*.

Cis-9, trans-11 conjugated linoleic acid (CLA) has been shown to be anticarcinogenic in a number of animal tumor models. Dairy products are the principal source of CLA in human diets and endogenous synthesis from vaccenic acid (*trans-11* 18:1; VA), the major biohydrogenation intermediate produced in the rumen, is the predominant source of CLA in milk fat. Foods rich in CLA are therefore also rich in VA. We previously reported that dietary VA caused a dose-dependent increase in the accumulation of CLA in the mammary fat pad; this was accompanied by a parallel decreased risk of tumorigenesis in the mammary gland. In an attempt to delineate a direct versus an indirect action of VA, the objective of this study was to determine whether treatment with sterculic oil (SO), a potent inhibitor of Δ^9 -desaturase, would reverse the cancer-protective effect of VA derived from milk fat. Female Sprague-Dawley

rats (9 per diet) were injected with a single dose of carcinogen (methyl-nitrosourea), and fed one of 4 diets: 1) low VA, 2) low VA + SO, 3) high VA, and 4) high VA + SO. After 6 wk, the mammary glands were evaluated histologically for the appearance of premalignant lesions, and tissues analyzed for fatty acids. Total premalignant lesions were 83, 80, 43 and 68 for treatment 1, 2, 3 and 4, respectively (P<0.05). In the same order, the CLA concentrations (g/100g fatty acids) in the mammary fat pad were 2.13, 2.14, 4.75 and 2.98, while the VA concentrations were 0.54, 0.74, 4.89 and 8.20 (P<0.001). Thus the feeding of VA increased mammary tissue level of CLA and reduced the risk of developing premalignant lesions in the mammary gland. Treatment with SO reversed the effects of VA. It is most likely that the anticarcinogenic effect of VA is mediated through its conversion to CLA via Δ^9 -desaturase, and when this conversion is blocked by sterculic oil, the biological response to VA is altered.

Key Words: Vaccenic Acid, Conjugated Linoleic Acid, Mammary Cancer

790 Relationships between somatic cell count and bacterial infection in Italian buffaloes. P. Boettcher*¹, A. Stella², G. Pisoni³, C. Sgoifo Rossi³, R. Fedeli³, M. Rinaldi³, and P. Moroni³, ¹*IBBA-CNR, Seagrata, Italy*, ²*CERSA-FPTP, Seagrata, Italy*, ³*University of Milan, Italy*.

The objective of this study was to examine factors affecting somatic cell count (SCC) and bacterial infection in Italian buffaloes. The data used in the study were 1930 test-day records of SCC and bacterial presence in each of the four udder quarters of 48 buffalo cows in two Italian herds. Nearly 65% of the records showed presence of bacteria. Fourteen different species were observed. *Staphylococcus* species were the most commonly observed bacteria, detected in 47% of the samples. *Streptococcus uberis* was the next most common, observed in approximately 8% of the samples. Various linear mixed models were used to determine the statistical significance of the effects of various factors on SCC. For this analysis, SCC was transformed to somatic cell score (SCS) using the standard log 2 transformation. Fixed effects in the model included herd, parity number (1, 2, 3, 4, 5, and > 6), days in milk, location of the quarter (e.g. left-front, right-rear, etc.), and infection status. Infection status was defined in two different ways. In the first, two classes were established: 1) free from bacteria and 2) infected with any species. The second approach had four groups: 1) uninfected, 2) infected with *Strep uberis*, 3) infected with a *Staphylococcus* species, and 4) infected with any other species. Cow and quarter-nested-within-cow were random effects in the model. No significant difference in SCS was observed across herds. Mean SCS tended to increase with age up until third lactation, and then decreased during later lactations. Consistent with previous studies in other species, SCS tended to increase as lactation progressed. Significant differences in SCS were observed among the different quarters of the udder, as SCS was highest in the front-left quarter (mean = 3.16) and lowest in the right-rear quarter (mean = 2.22). When infection status was defined as "infected" or "healthy", SCS was slightly higher in infected quarters, but the difference was not significant. The analysis based on different bacterial groups indicated that only *Strep uberis* was associated with significantly (P #8804 0.0006) elevated levels of SCS (3.29 vs. 2.37) with respect to uninfected quarters.

Key Words: Somatic Cell Score, Mastitis, Buffalo

Nonruminant Nutrition: Sow Feeding

791 A new sow model to study amino acid arterio-venous differences and uptake by the mammary gland before and after farrowing. Z. Mroz*¹, W. Krasucki², and S. J. Koopmans¹, ¹*Wageningen University and Research Centre, Division Nutrition and Food, Lelystad, The Netherlands*, ²*Agricultural University of Lublin, Poland*.

A new sow model was developed to study the post-absorptive kinetics of amino acids in the mammary gland during pre- and postfarrowing periods. For this purpose, six multiparous sows at late pregnancy were fitted with three blood catheters (*A. epigastrica cranialis superficialis*, *A. iliaca externa*, *V. epigastrica cranialis superficialis*) to measure: 1) arterio-venous differences (AVD), extraction rate (ER) and uptake

of essential amino acids in the mammary gland, and 2) blood acid-base characteristics as affected by two factors - sampling time (pre-prandial versus post-prandial) and phase of the reproductive cycle (pre- and post-farrowing). The AVD, ER and amino acid uptake in the mammary gland of sows as affected by the post-farrowing phase are presented in Table 1. In general, we found that this new sow model can be useful for studying dynamics of essential amino acids uptake for colostrum or milk synthesis. Also, the requirement of the mammary gland in pregnancy and lactation for specific amino acids can be estimated.

Amino acid arterio-venous differences (ADV), extraction rate (ER) and amino acid uptake in the mammary gland of sows as affected by the post-farrowing phase

Lactation day:	ADV ($\mu\text{mol/L}$)			ER (%)			Uptake (g/4 h)		
	3	10	P-value	3	10	P-value	3	10	P-value
Lys	97.5	34.8	<0.001	78.9	43.8	<0.001	13.0	4.8	<0.001
Met	25.5	11.0	<0.001	65.9	28.9	<0.001	3.2	1.2	<0.001
Try	26.2	8.3	<0.001	39.9	19.7	<0.001	4.6	1.7	<0.001
Arg	106.9	41.6	<0.001	78.6	35.1	<0.001	15.0	5.4	<0.001
His	30.8	10.8	<0.001	45.0	16.9	<0.001	3.2	1.3	<0.001
Ile	81.5	33.0	<0.001	67.8	44.1	<0.001	9.1	3.3	<0.001
Leu	161.5	57.9	<0.001	59.0	37.9	<0.001	17.1	6.6	<0.001
Phe	55.7	21.8	<0.001	65.4	28.0	<0.001	8.0	2.7	<0.001
Thr	82.0	32.2	<0.001	54.8	24.7	<0.001	8.0	2.7	<0.001
Val	113.6	39.9	<0.001	45.3	25.6	<0.001	10.2	3.5	<0.001

Key Words: Sow, Mammary Gland, Amino Acid Uptake

792 Changes in composition in various body tissues in pregnant gilts and its nutritional implication. F. Ji^{*1}, G. Wu², J. R. Blanton Jr.¹, and S. W. Kim¹, ¹Texas Tech University, Lubbock, ²Texas A&M University, College Station.

Thirty-five gilts (158.2±3.8 kg) were randomly assigned to seven slaughter groups: d 0, d 45, d 60, d 75, d 90, d 102, d 112 and were fed 2 kg/d gestation diet (3.1 Mcal/kg ME and 0.56% lysine) until their slaughter. Soft tissue, gastrointestinal tract (GIT), liver, uterus, fetus, mammary gland, and remaining viscera (RV) were separated, weighed, ground, sampled, freeze dried, and chemically analyzed. Dry matter and crude fat contents in soft tissue increased linearly ($P<0.01$), whereas crude protein content in soft tissue increased cubically ($P<0.05$) during gestation. Dry matter, crude protein, and crude fat contents in uterus including placenta increased linearly ($P<0.01$) during gestation. Dry matter, crude protein, and crude fat contents in entire mammary gland increased quadratically ($P<0.01$) during gestation. Dry matter and crude fat contents in RV increased quadratically ($P<0.01$) during gestation. Dry matter, crude protein, and crude fat contents in fetal litter increased cubically ($P<0.01$) during gestation. Dry matter and crude protein contents in GIT decreased cubically ($P<0.01$) during gestation. Crude protein content in liver decreased linearly ($P<0.05$), whereas crude fat content increased quadratically ($P<0.01$) during gestation. Dry matter, crude protein, and crude fat contents in total increased quadratically ($P<0.01$) during gestation. The ADG of conceptus, fetal litter, individual fetus, entire mammary gland, and crude protein in fetal litter were significantly different before and after d 70 of gestation. The protein daily gain from all the maternal and fetal tissues was 40 g/d before d 70 of gestation and 103 g/d after d 70 of gestation suggesting that pregnant gilts may require different amounts of dietary protein during gestation. Considering the needs of maternal and fetal gains as well as maintenance, we suggest that the diet of pregnant gilts should provide 6.8 g/d (or 147 g/d) before d 70 and 15.3 g/d (or 330 g/d) after d 70 of gestation to support the accurate true ileal digestible lysine (or true ileal digestible protein) needs.

Key Words: Gestating Sows, Composition, Lysine Requirement

793 Ideal protein to improve lactation performance of primiparous sows. S. W. Kim^{*1}, F. Ji¹, and Y. G. Kim^{*2}, ¹Texas Tech University, Lubbock, ²CJ Corporation, Seoul, Korea.

The objective was to validate the ideal dietary amino acid pattern in lactation diets to improve the performance of primiparous sows during lactation. Twenty four primiparous sows (Camborough-22, PIC) and their litters were used for this study. On d 109 of gestation, sows were allotted to one of four dietary treatments representing: low protein (LC), low protein with ideal protein (LI), high protein (HC), and high protein with ideal protein (HI). Low protein diets contained 17.5% CP and high protein diets contained 19.5% CP. Ideal amino acid patterns among lysine, threonine, and valine were 100:63.0:78.1 for the LI diet and 100:62.3:77.5 for the HI diet when it was calculated based on ileal digestible amounts. To match amino acid pattern to ideal ratios, crystalline amino acids were supplemented. Crude protein content in the diets with ideal protein pattern were matched to the control diets by adjusting SBM content as crystalline amino acids were added. Weight and backfat thickness of sows as well as the weight of each piglet were measured at farrowing and weekly until weaning at d 21 of lactation. All sows had free access to feed and water during lactation. The body weight of sows after farrowing (207.5±7.6 kg) and litter size at farrowing (10.3±0.3 pigs) were the same ($P=0.361$ and 0.544, respectively)

among the treatments. Voluntary feed intake of sows (4.95±0.22 kg/d) did not differ ($P=0.879$) among the treatments. For the sows fed the low protein diets, there were no differences in weight loss and backfat loss during 21-d lactation between the LI and LC. However, litter weight gain of the LI was greater ($P<0.05$) than the LC. Litter size at weaning was greater ($P<0.05$) for the LI than the LC. For the sows fed the high protein diets, there were no differences in weight loss and backfat loss during 21-d lactation between the HI and HC. Litter size at weaning and litter weight gain were the same between the HI and HC. For all the sows, litter weight gain was improved ($P<0.05$) and litter mortality was reduced ($P<0.05$) whereas body weight loss was not affected ($P=0.841$) by the utilization of ideal protein.

Key Words: Lactation, Ideal Protein, Primiparous Sows

794 Supplementation of sow diets with a mixture of carvacrol, cinnamaldehyde and capsicum; effects on sow performance and piglet gut morphology. S. Illey^{*1}, H. Miller¹, and C. Kamei², ¹University of Leeds, Leeds, UK, ²AXISS France SAS, Bellegarde-sur-Valserine, France.

Many plant extracts contain bioactive compounds that can affect pig performance and health. This study investigated the effects of a combination of 5% carvacrol, 3% cinnamaldehyde and 2% capsicum oleoresin (XTRACT) on sow and piglet performance. Forty-four hybrid sows of mixed parity and fatness were housed in indoor farrowing crates from d107 of gestation to weaning. Sows were allocated, by parity, fatness and history, to one of 2 dietary treatments: Control (C) or XTRACT(XT, 100mg/kg feed). Diets were otherwise identical, with 14 MJ DE/kg and 1% lys. Before farrowing, sows received 2.5kg/d but were thereafter fed ad libitum with feed intake (FI) recorded daily. Piglet liveweight and sow P2 backfat were recorded and milk sampled at birth and d21. On d24 (weaning), 16 piglets per treatment were slaughtered. Data were analysed using the GLM procedure of Minitab 12.2. Sow FI was similar between treatments, however P2 backfat loss was lower in XT sows (0.98 v 2.1mm, $P<0.1$, SEM=0.5). Lactose levels in colostrum and milk were greater for XT sows (d 0: 2.8 v 2.4% $P<0.1$, SEM=0.1; d 21: 5.4 v 4.9% $P<0.01$, SEM=0.1) but fat and protein concentrations did not differ. Milk IgG was lower in XT sows (d0: 94 v 106mg/ml, $P<0.1$, SEM=5.9; d21: 0.65 v 0.72mg/ml, $P<0.1$, SEM=0.02). Piglet pre-weaning gain was not affected by sow treatment. However in the distal small intestine, villus height was greater in pigs suckling XT sows (413 v 312 μm , $P<0.05$, SEM=32) and villus-crypt surface area was higher (165 v 134 $\mu\text{m}^2 \times 10^3$, $P<0.1$, SEM=14). Reduced P2 loss in XT sows and increased milk lactose suggest an effect on nutrient partitioning. Lower milk IgG levels may indicate decreased immune stimulation due to reduced microbial challenge in XT sows. Changes in piglet gut morphology were not reflected in performance but may indicate a carry-over from sow to piglet in the XT group.

Key Words: Plant Extracts, Lactation, Piglet

795 Comparison of ad-libitum and hand-fed sow lactation feeders. J. Peng^{*}, S. Somes, D. Kirkpatrick, A. Snedegar, and D. Rozeboom, Michigan State University, East Lansing.

A study was conducted to compare the performance of lactating multiparous sows when feed was made available to them using either a hand-fed (HF) or ad libitum (AL) feeder. Both feeders were made of stainless steel and mounted to the head-gates of individual farrowing crates. Sow head space was similar. The bottom of the HF feeder was rounded, whereas the bottom of the AL feeder included a flat surface area, located below a plastic hopper and sow-operated dispensing mechanism, and a shallow bowl area, located below a water nipple. Water for HF sows was provided using a nipple-cup combination independent of the feeder. Sows (n=120) were assigned to feeder treatment based on parity and breed, and moved into farrowing rooms within 7 d prior to parturition. Sows were fed a common lactation diet that met or exceeded NRC (1998) recommendations. Feed was manually added to the hoppers of AL feeders 1 to 2 times daily so that fresh feed was constantly available, while HF sows were fed to appetite (an amount slightly exceeding disappearance in previous meals), twice each day (800 and 1600 hr). A system for collection of wasted feed and water was installed under half of HF and AL farrowing crates which had individual water tanks for measuring water intake. Cross-fostering was used to standardize litter size at a minimum of 10 by d 3 of lactation. Average lactation length was 19.8 ± 0.2 d. Average daily feed disappearance (6.3 ± 0.3 vs. 5.9

± 0.3 kg) and litter wt gain from d 3 until weaning (42.7 ± 2.0 vs. 39.2 ± 2.2 kg) were greater (P < 0.01) with AL feeders than with HF feeders, respectively. Number of pigs weaned did not differ (P > 0.05, 9.7 ± 0.1). The AL sows tended to have greater (P = 0.07) wt gains during lactation (12.2 ± 3.1 vs. 8.2 ± 3.2 kg, AL and HF, respectively). Backfat change during lactation and wean-to-estrus interval did not differ (P > 0.05). Sows with AL feeders wasted less (P < 0.01) water than sows with HF feeders (12.7 ± 14.8 vs. 236.0 ± 20.7 kg, respectively), but water intake and feed waste was similar (P > 0.05). Sows given ad libitum access to feed during lactation responded with productivity.

Key Words: Sow, Lactation, Feeder

796 Interactive effects of milk supplementation, parity and season on preweaning mortality and growth performance of piglets on a commercial farm. B. W. Ratliff¹, A. M. Gaines¹, G. L. Allee¹, M. O'Brien², and J. A. Coalson², ¹University of Missouri, Columbia, ²Merrick's, Inc., Union Center, WI.

A total of 703 (Genetiporc) sows and 7,301 piglets (PIC 337 × Genetiporc) were used on a commercial farm to evaluate the interactive effects of milk supplementation, parity and season on piglet growth performance and pre-weaning mortality. Data were collected over a 12 month period. Sow diets were formulated to meet all minimal NRC requirements. Sows were grouped according to parity as follows: parity 1 =

group 1, parities 2 and 3 = group 2, and all parities greater than 3 = group 3. Litters from sows within the same group were randomly allotted to either milk or no milk treatments. At 48 h post parturition, milk supplementation was initiated and piglets were counted and weighed. All cross-fostering and litter processing occurred prior to 48 h. Mortalities, their weights, and date of occurrence were recorded daily for each litter. At d 14 to 18, each litter was weighed, counted, and weaned. Data indicated that milk supplementation increased (P < 0.05) number of pigs weaned, weaning weight and total litter gain (includes mortality weights), while lowering (P < 0.05) pre-weaning mortality. Parity groups 1 and 2 weaned more (P < 0.05) pigs per sow and had lower (P < 0.05) pre-weaning piglet mortality than parity group 3. Furthermore, parity groups 1 and 3 had lighter (P < 0.05) weaning weights, piglet average daily gains and total litter gains than parity group 2. Warm season decreased (P < 0.03) piglet average daily gain. Treatment by parity group interactions (P < 0.05) were present for number of pigs weaned, litter weaning weight, pre-weaning mortality and total litter gain, with milk supplementation being most beneficial for parity group 2 and 3 sows. Milk supplementation did not affect (P > 0.05) any parameters measured in parity group 1 sows. Collectively, these data indicate that milk supplementation will improve litter growth performance and decrease pre-weaning mortality in parity 2+ sows.

Key Words: Milk Supplement, Piglets, Sows

Production, Management and the Environment: Nutritional Management

797 Blood metabolites during the transition period of Holstein cows receiving a monensin controlled-release capsule. P. Melendez^{*1}, J. Goff³, C. Risco¹, L. Archbald¹, R. Littell², and A. Donovan¹, ¹College of Veterinary Medicine, University of Florida, Gainesville, ²Institute of Food and Agricultural Sciences, University of Florida, Gainesville, ³National Animal Research Center, USDA, Ames, IA.

Monensin increases the rumen molar proportion of propionate. This change might affect energy metabolic dynamics in transition dairy cows. The objective of this study was to determine the effect of a rumen monensin-controlled release capsule inserted at dry-off on energy blood metabolites in Florida transition cows fed diets containing citrus pulp. The study was conducted on a Holstein farm with 3600 milking cows in north central Florida, with a RHA of 10,700 kg. Cows were housed in a dry-lot system and fed the same TMR 3X. In March, 2002, 24 cows dried-off 50 to 70 d before expected parturition (BEP) were randomly assigned either a treatment or a control group. The treated group (n=12) received orally a capsule of monensin (300 mg/d for 95 d, CRC Rumensin[®]). Control cows (no capsule, n=12) were randomly matched by parity. At assignment, on day 21 BEP, at calving, and at 7, 14, and 21 d postpartum (pp) a blood sample was obtained from the coccygeal vein and body condition scoring (BCS) was conducted (scale 1-5). Serum non-esterified fatty acids (NEFA), beta-hydroxy butyrate (BHB) and glucose were measured. Metabolites were analyzed by ANOVA, mixed model for repeated measures. BCS changed over time, and treatment increased BCS significantly in multiparous cows at calving (P ≤ 0.01). BHB was lower in treated primiparous cows at calving (0.52 ± 0.2 vs 0.90 ± 0.1 mmol/L) (P ≤ 0.1) and 14 d pp (0.36 ± 0.2 vs 0.90 ± 0.1 mmol/L) (P ≤ 0.05) and NEFA were lower in treated primiparous cows at 7 d pp (0.78 ± 0.3 vs 1.42 ± 0.2 meq/L) (P ≤ 0.05) and 14 d pp (0.44 ± 0.3 vs 0.91 ± 0.2 meq/L) (P ≤ 0.1). Independent of treatment, NEFA, BHB and glucose increased dramatically at 21 d BEP, indicating that cows around 3 wks prepartum started to change their metabolic status. It was concluded that transition primiparous cows under the influence of monensin and fed a TMR containing citrus pulp had lower levels of BHB, and NEFA at certain times of the transition period. BCS at calving was significantly higher in multiparous treated cows.

Key Words: Monensin, Blood Metabolites, Transition Dairy Cow

798 Rumen and blood metabolites at 10 d postpartum in Holstein cows supplemented with monensin. P. Melendez^{*1}, J. Goff², C. Risco¹, L. Archbald¹, R. Littell³, and A. Donovan¹, ¹College of Veterinary Medicine, University of Florida, Gainesville, ²National Animal Research Center, USDA, Ames, IA, ³Institute of Food and Agricultural Sciences, Gainesville, FL.

The objective was to assess the effect of a monensin controlled-release capsule inserted at dry-off on rumen and energy blood metabolites at 10 d postpartum (pp) in transition cows fed Florida typical diets. The study was conducted on a Holstein dairy with a RHA of 10,700 kg. In March, 2002, 24 cows were randomly assigned at dry-off to 2 groups. Treated cows (n=12) received an oral capsule of monensin (300 mg/d for 95 d, CRC Rumensin). Control cows (n=12) were not treated and matched by parity. At 10 d pp a rumen and blood sample was obtained at 7 A.M. before the first meal. Other samples were taken at 2, 4 and 6 h after feeding (AF). Rumen sample was taken by an orominal tube. Rumen pH was measured immediately after sampling. Serum non-esterified fatty acids (NEFA), beta-hydroxy butyrate (BHB) and glucose were measured by enzymatic colorimetric methods. Rumen samples were analyzed for concentration of VFA, lactic acid and NH3. Variables were analyzed by ANOVA, mixed models for repeated measures. Primiparous controls tended to have lower rumen pH at 4 h AF than treated cows (6.34 vs 6.62) (P ≤ 0.10). Multiparous treated cows tended to have lower NH3 at 4 h AF (4.28 vs 5.01 mmol/L) (P ≤ 0.10) and had significantly lower NH3 at 6 h AF (2.8 vs 4.01 mmol/L) (P ≤ 0.05) than controls. In treated primiparous, BHB tended to be lower at 2 h AF (0.65 vs 1.0 mmol/L) and 6 h AF (0.71 vs 0.99 mmol/L) (P ≤ 0.1) and was lower at 4 h AF (0.57 vs 1.0 mmol/L) (P ≤ 0.05) than controls. NEFA tended to be lower at time 0 (0.82 vs 1.14 meq/L) (P < 0.1) and glucose tended to be higher at 2 h AF (54.4 vs 45.9 mg/dL) (P ≤ 0.1) in treated than controls. In treated multiparous cows, BHB tended to be lower at 4 h AF (0.77 vs 1.05 mmol/L) (P ≤ 0.1) and was lower at 6 h AF (0.82 vs 1.18 mmol/L) (P ≤ 0.05) than controls. NEFA were lower at 2 h AF in treated than controls (0.59 vs 0.92 meq/L) (P ≤ 0.05). Glucose tended to be higher at 2 h AF in treated than controls (51.2 vs 46.3 mg/dL) (P ≤ 0.1) It was concluded that transition cows under monensin had improved energy status within 6 h AF.

Key Words: Monensin, VFA, Transition Dairy Cow

799 Warm-season baleage crops for mid-lactation Holstein cows. M. E. McCormick^{*}, Southeast Research Station, Louisiana State University, Franklinton.

Conserving forage as baleage is becoming widely accepted by Louisiana dairymen. In the present study, production-scale pastures of bermudagrass (*Cynodon dactylon*, L.), signalgrass (*Brachiaria decumbens*, S.)

and forage sorghum (*Sorghum bicolor*, L.) were used to evaluate the effect of forage type on nutrient composition and feeding value of crops conserved as baleage. Annual ryegrass (*Lolium multiflorum*, L.) served as a positive control. Forages were cut, windrow-wilted for 24-48 h, baled, and wrapped with white stretch film. Following a six-month storage period, baleages were fed to forty multiparous, midlactation Holstein cows (30.1 ± 3.2 kg FCM, 181 ± 32 DIM) in a 42-d randomized block design feeding trial. Forages were individually fed (Calan Gate barn) ad libitum and concentrates (6.1 kg DM/feeding) were fed immediately prior to a.m. and p.m. milkings. Milk weights were recorded at each milking, milk samples were collected weekly for compositional analyses, and body weight/condition scores were measured weekly. Signalgrass ADF and NDF concentrations were lower and in vitro digestibility was higher than those recorded for either bermudagrass or sorghum baleages. Protein concentrations were higher for signalgrass and ryegrass than either bermudagrass or sorghum baleages (16.9 and 16.0% vs 13.1 and 13.4%, respectively). Sorghum baleage intake was lower ($P < 0.05$) than that recorded for ryegrass, signalgrass, and bermudagrass (8.3, 9.6, 10.7, and 12.3 kg DM/d, respectively). Actual milk (kg/d), FCM (kg/d), and % milk fat were 27.5, 27.3, 3.58; 28.0, 26.9, 3.31; 28.7, 28.7, 3.52; and 29.9, 29.7, 3.37 for bermudagrass, sorghum, signalgrass, and ryegrass baleages, respectively. Other animal measurements such as body weight (avg. = 664 kg), condition score (avg. = 2.64), and rumen pH (avg. = 6.28) did not differ with forage type. Under management conditions employed in this study, signalgrass nutrient composition and feeding value were similar to annual ryegrass. Sorghum and bermudagrass baleages tended ($P < 0.10$) to have inferior nutrient composition and produce less milk than either signalgrass or ryegrass baleage crops.

Key Words: Baleage, Feeding Trial, Milk Production

800 Evaluating the distribution of fatty acids in the middle and outer layer of market pigs challenged with conjugated linoleic acid. A. Cox*, A. Schinckel, B. Richert, and M. Latour, *Purdue University, West Lafayette, IN.*

A study was conducted to investigate the ability of conjugated linoleic acid (CLA) to alter pig fatty acid distribution within the middle and outer backfat layers during the last 14 and 28 days of the finishing period. Forty-two barrows from a single source were used. Six pigs were slaughtered upon arrival to obtain baseline data. The remaining thirty-six pigs were individually penned and then equally and randomly assigned to control, 0.5% CLA or 1.0% CLA. Eighteen pigs (six per treatment) were sampled on each sampling day. Regardless of layer, there were significant ($P < 0.05$) treatment differences in the percentage of C14:0, C16:0, C16:1, C18:0, C18:1, C18:2, C18:2 9-11, C18:2 10-12, C20:1, C20:4, and C20:5. Both levels of dietary CLA decreased the levels of unsaturated fatty acids compared to control. Conversely, the pigs fed CLA exhibited an overall higher percentages of saturated fatty acids compared to control pigs. Regardless of treatment, significant ($P < 0.05$) differences were observed between the middle and outer backfat layers. The percentage of C16:1, C18:1, and C18:2 were significantly higher ($P < 0.05$) in the outer layer, compared to the middle layer. However, the levels of C18:0 and C20:0 were significantly ($P < 0.05$) higher in the middle layer compared to the outer layer. These data indicate that dietary CLA can alter the fatty acid composition of fat, whereas the differences between layers tends is relatively unaffected by the dietary treatments imposed.

Key Words: Swine, CLA, Fatty Acids

801 Effect of feeding a low nutrient excretion diet on pig growth performance and carcass characteristics in a commercial wean-finish setting. R. B. Hinson*, M. C. Walsh, D. M. Sholly, S. A. Trapp, D. T. Kelly, J. S. Radcliffe, A. L. Sutton, A. P. Schinckel, and B. T. Richert, *Purdue University, West Lafayette, IN.*

Two hundred fifty-six pigs (Initial BW = 25.8 kg) were randomly selected within four 1,000 hd commercial wean-finish swine buildings to determine the effects of feeding a control (CTL) corn-SBM based diet or a low nutrient excretion (LNE) diet, with synthetic amino acids and phytase, on grow-finish (G-F) pig growth, carcass characteristics, and live ultrasound backfat (BF) and loin eye area (LEA). Two barns were fed CTL diets and two fed LNE diets. Six phases of each trt were fed during the G-F period. Thirty-two pigs/sex/barn had individual BW and ultrasound measurements recorded at 3 wk intervals. After 15 wk

on test, 10 pigs/sex/barn were harvested to determine carcass characteristics. Initial BW differed ($P < .01$) between CTL and LNE (24.6 vs. 26.9 kg) and barrows and gilts (24.9 vs. 26.7 kg). ADG for grower (wk 0-9), finisher (wk 9-15), and overall (wk 0-15; 861 vs. 807 g/d) were higher ($P < .01$) for CTL vs. LNE. Barrows had greater overall ADG ($P < .05$; 853 vs. 815 g/d) than gilts. For finisher ADG gilts grew 7 g/d slower than barrows when fed CTL diets, but had 84 g/d lower ADG when fed LNE diets ($P < .05$). Wk 15 LEA and LEA change (31.10 vs. 27.35 cm²) were higher ($P < .001$) for CTL vs. LNE. Final 10th rib (8.8 vs. 6.7 mm) and last rib ultrasound BF change was higher ($P < .05$) for barrows vs. gilts, while LEA change was not different ($P > .50$). Carcass last rib BF (23.7 vs. 21.4 mm), and loin eye color (2.61 vs. 2.44) and firmness (2.94 vs. 2.75) were different ($P < .04$) for CTL and LNE, respectively. Carcass 10th rib (18.6 vs. 14.5 mm), last rib, and last lumbar BF, LEA (42.5 vs. 46.0 cm²), and predicted fat free lean (46.68 vs. 48.42%) were different ($P < .05$) between barrows and gilts, respectively. In a commercial setting with significant disease pressure, feeding a LNE diet did not maintain growth performance compared to a standard corn-SBM diet. However, ribbed carcass characteristics were similar between the LNE and CTL diets.

Key Words: Pigs, Reduced Crude Protein, Growth

802 Finishing steer performance on diets with added vegetable oil. G. M. Hill*¹, S. K. Duckett², J. F. Baker¹, E. Paven², and B. G. Mullinix¹, ¹*University of Georgia, Tifton*, ²*University of Georgia, Athens.*

Effects of adding no vegetable oil (Control), low oil (LO, 4.7 % of DMI), or high oil (HO, 7% of DMI) on steer performance during the last 57 d of a 100-d steer finishing experiment were determined. Steers (n=40; 4 Polled Hereford, 3 Simmental X Angus, 33 Angus; initial BW 435.2 ± 27.8 kg) were randomly assigned to six pens and three treatments and implanted with Synovex-S[®] on d 1. Diets contained corn silage (CS; 41% DM, 8.6% CP) and a concentrate mixture (CM; 89.1% DM, 13.72% CP; 88.1% dry rolled corn, 10.0% soybean meal, 1.9% vitamin/mineral premix; Rumensin[®] at 33 mg/kg CM). A total mixed ration consisted of CM and CS was fed free-choice, with CS fed at 24.4% and 20.6% of dietary DM, respectively, during the preliminary period (B4O; d 1 to d 43), and when oil was fed (WO; d 43 to d 100). Steer rib fat (RF, cm) was measured using ultrasound on d 2 and d 100, and RF (Table) with initial BW as a covariate was not affected by treatments ($P < 0.22$). Steer least square means for ADG B4O with initial BW as a covariate were similar for treatments, but ADG WO and ADG 100 d were lower than Control ($P < 0.08$) using ADG B4O (mean 1.87 kg) as a covariate. The DMI decreased for HO during WO ($P < 0.06$) and for the 100-d experiment ($P < 0.02$), and DM/gain tended to increase for HO during WO ($P < 0.08$) and for the 100-d experiment. Feeding oil tended to reduce steer performance, with the greatest reductions occurring on the HO treatment.

Item	Control	LO	HO	SE	P
ADG, kg B4O	1.71	2.00	1.89	0.13	0.43
DMI, kg B4O	9.32	10.22	9.37	0.16	0.10
DM/gain B4O	5.50	5.12	5.49	0.34	0.61
RF, cm D 2	1.35	1.17	1.37	0.12	0.37
ADG, kg WO	1.95	1.82	1.12	0.19	0.08
DMI, kg WO	10.26	11.88	8.97	0.34	0.06
DM/gain WO	5.38	6.53	8.22	0.40	0.08
ADG, kg 100d	1.92	1.84	1.44	0.11	0.08
DMI, kg 100d	10.28	11.16	9.10	0.12	0.02
DM/gain 100 d	5.66	5.88	6.32	0.17	0.20
RF, cm 100d	3.86	3.22	3.15	0.29	0.23

Key Words: Steer, Gain, Oil

803 Effect of oil supplementation to finishing cattle on carcass quality and subcutaneous fat composition. E. Pavan*¹, S. Duckett¹, and G. Hill², ¹*The University of Georgia, Athens*, ²*The University of Georgia, Tifton.*

Forty steers (4 Polled Hereford, 4 Simmental x Angus, 32 Angus) were used to study the effect of adding no vegetable oil (NO), low oil (LO, 4.7% of DMI), or high oil (HO, 7% of DMI) during the last 57 d of the finishing period on carcass traits and fatty acid (FA) composition.

The basal diet consisted of 20.6% corn silage and 79.4% concentrate mix (88.1% corn, 10% soybean meal). Carcass data was collected at 24 h postmortem and carcass value calculated based on current grid prices. Fatty acid composition was determined from subcutaneous (SC) fat by GLC. Carcass weight was higher for NO and LO than for HO (360, 362 and 334 kg, respectively; SE= 5.3; P=0.05). Neither kidney-pelvic-heart fat (2.7± 0.1% of carcass weight), nor SC fat thickness (1.42± 0.07 cm), intramuscular fat (587± 17 marbling score; 500= small), or ribeye area (79± 1.6 cm²) were affected by oil level. Both yield (3.5± 0.1) and quality grades (5.3± 0.2; 5= choice-) were similar between treatments. The product value per kg (3.61± 0.04), and the total carcass value (2795± 48) were not affected by level of oil. However, SC fatty acid composition (% of total FA) was changed by the level of oil supplied. While total monounsaturated FA decreased by oil supplementation (P<0.01), total trans-octadecanoic acids increased (P<0.01) and PUFA tended to increase (P=0.06) when oil was added. This was mainly due to reductions of oleic acid concentration and increases in the concentration of trans-10 octadecanoic, linoleic acid and total conjugated linoleic acid (CLA; P<0.01). The ratio of n6:n3 was increased by oil supplementation (NO: 4.4 and 5.5 for oil treatments; SE= 0.15; P<0.01). The t10c12 isomer of CLA increased linearly with the addition of oil (HO: 0.01, LO: 0.05 and HO: 0.07%; SE= 0.003; P<0.01); whereas c9t11 was higher in HO (0.59%), but lower in LO (0.39%; SE= 0.02; P<0.01). Supplementing various levels of vegetable oil to high concentrate diets did not alter carcass quality but increased linoleic, trans-10 octadecanoic, and conjugated linoleic acids in subcutaneous adipose tissue.

Key Words: Beef, Carcass Quality, Fatty acids

804 Effects of supplement type on growth and pregnancy rate of yearling, Brahman-crossbred heifers. J. D. Arthington^{*1}, G. C. Lamb², and F. M. Pate¹, ¹Range Cattle Research and Education Center, University of Florida, Ona, ²North Central Experiment Station, University of Minnesota, Grand Rapids.

The effects of winter supplement type on growth and pregnancy rate of fall-born, yearling heifers was investigated over 2 consecutive yr. During both years, heifers were stratified by breed (Braford and Brangus-crossbred) and BW and randomly assigned to one of two treatments consisting of (1) wheat middling-based range cube, or (2) molasses-cottonseed meal slurry (n = 34 and 24 heifers/treatment for yr 1 and 2, respectively). Supplements were fed at rates to achieve a target of 1.47 and 0.34 kg of supplemental TDN and CP daily, respectively. Four limpograss (*Hemarthria altissima*) pastures were utilized each year (n = 2 pastures/treatment; 0.71 and 0.51 ha/heifer for yr 1 and 2, respectively). All heifers were allowed free-choice access to stargrass (*Cynodon nlemfuensis*) hay during periods of limited pasture forage availability. During a 70-d breeding season, heifers were combined by group and exposed to mature Angus bulls. Bulls were rotated among pastures each week. Individual heifer BW and hip height were collected at the start of supplementation and at the start and end of the breeding season. Pregnancy rate was determined by transrectal ultrasonography in late April of each year (minimum of 40 d after the end of breeding). There were no treatment x year, breed x treatment, or breed x year interactions for heifer ADG (P > 0.10). Supplement type did not affect heifer ADG (0.44 and 0.47 kg/d for molasses-slurry and range cubes, respectively). Heifers consuming molasses-slurry had a greater (P < 0.01) overall pregnancy rate compared to heifers consuming range cubes (76.3 vs 49.2% pregnant). Irrespective of treatment, Brangus-crossbred heifers had a greater pregnancy rate (P < 0.01) than Braford heifers (73.2 vs 46.8%). These data indicate that yearling heifers, supplemented with molasses-cottonseed meal slurry, may have increased pregnancy rates compared to heifers supplemented with a wheat middling-based range cube. This response appears to be independent of heifer ADG.

Key Words: Heifer, Molasses, Wheat Middling

805 Effects of supplemental yeast fermentation product on early-weaned calf performance while grazing winter ryegrass summer stargrass pastures in Florida. J. D. Arthington¹, S. Galindo-Gonzalez^{*1}, J. M. B. Vendramini^{1,2}, R. S. Kalmbacher¹, P. Mislevy¹, L. E. Sollenberger², and I. Yoon³, ¹Range Cattle Research and Education Center, University of Florida, Ona, ²Department of Agronomy, University of Florida, Gainesville, ³Diamond V, Cedar Rapids, IA.

The objective of this study was to investigate the effectiveness of a supplemental yeast fermentation product (YFP) on the performance of early weaned calves grazing winter annual ryegrass (*Lolium multiflorum*, 112 d) followed by summer perennial stargrass (*Cynodon* spp., 112 d) in Florida. Ryegrass was seeded at a rate of 16.8 kg/ha in early November, and provided three applications of fertilizer (336 kg/ha; 16-4-16, plus micronutrients). Established stargrass pastures were provided an initial fertilizer application (March; 336 kg/ha, 0-10-20, plus micronutrients) followed by three applications of N (56 kg/ha) during the summer grazing period. Twenty-four calves were early weaned from primiparous cows (66 ± 11 d of age) and randomly allotted to one of eight groups (0.30 and 1.0 ha/calf for ryegrass and stargrass, respectively). All calves received supplemental feed (14 and 75% CP and TDN, respectively) at a rate of 1.0% BW daily. Two treatments were randomly allocated to calf groups (4 groups/treatment) consisting of, 1) commercial yeast fermentation product (YFP, 28 g/d; Diamond V Mills, Cedar Rapids, IA), or 2) a blended corn soybean meal Control. Average available forage did not differ among treatments (P > 0.40), but was greater (P < 0.01) for stargrass compared to ryegrass (0.92 and 6.11 tons DM/ha for ryegrass and stargrass, respectively; SEM = 0.09 and 0.22). Average forage DM digestibility did not differ among treatments (P > 0.26), but was lesser (P < 0.01) for stargrass compared to ryegrass (in vitro organic matter digestibility = 85.1 and 52.9% for ryegrass and stargrass, respectively; SEM = 1.15 and 1.45). Supplementation of YFP did not affect (P = 0.39) calf ADG during ryegrass grazing (0.88 and 0.83 kg/d for Control and YFP, respectively; SEM = 0.04), or during stargrass grazing (P = 0.12) (0.64 and 0.57 kg/d for Control and YFP, respectively; SEM = 0.03). These data suggest that under the grazing management systems used in this study, supplemental yeast fermentation product was ineffective for improving growth performance of grazing early-weaned calves.

Key Words: Calves, Weaning, Ryegrass

806 Response of cow/calf pairs grazing fescue and individually-supplemented with gradient levels of FEB-200TM. D. K. Aaron^{*1}, D. G. Ely¹, J. Wyles¹, and V. Akay², ¹University of Kentucky, Lexington, ²Alltech, Inc..

Angus x Beefmaster cow/calf pairs grazed endophyte-infected (> 90%) KY 31 tall fescue and were supplemented with 0, 10, 20, or 40 g·hd⁻¹·d⁻¹ of FEB-200TM (modified glucomannan, Alltech, Inc., Nicholasville, KY) carried in 0.45 kg ground shelled corn beginning May 6. Cattle were managed in eight pastures (two pastures/supplement level) stocked with 10 to 16 cow/calf pairs until July 15 at which time 20 predesignated cow-calf pairs were allotted to individual 1.6-ha plots of equivalent pasture. Cows continued their respective supplement regimes from this date until calves were weaned October 28. Cow weight changes from May 6 to July 15 were -40, -26, 3, and -23 kg/hd (Quadratic; P < 0.01) and 56, 45, 34, and 67 kg/hd (Quadratic; P < 0.01) from July 15 to October 28 for the 0, 10, 20, and 40 g/d supplement levels. Total cow gains from May 6 to October 28 increased linearly (P < 0.05) as level of supplementation increased. No differences were found for calf gains from May 6 to July 15, but calves gained 87, 96, 107, and 106 kg/hd (Linear; P = 0.12) from July 15 to October 28. A similar linear trend was found for overall calf gains (138, 155, 171, and 172 kg/hd; NS). Tympanic temperatures, monitored at 30-min intervals from July 21 through 24, averaged 38.4, 38.4, 38.3, and 38.5 °C (Quadratic; P = 0.10). Average tympanic temperatures measured from August 22 through 25 were not significantly affected by supplement level. Absence of a greater supplementation effect on deep body temperature may be a result of cool ambient temperatures during the measurement periods (avg. 24 °C). Overall, these results show supplementation with 40 g·hd⁻¹·d⁻¹ of FEB-200TM can increase production of cows and calves grazing endophyte-infected tall fescue.

Key Words: Fescue, Production, Cows

807 Response of cows and calves to gradient levels of a supplemented modified glucomannan when grazing tall fescue. D. G. Ely^{*1}, D. K. Aaron¹, J. Wyles¹, and V. Akay², ¹University of Kentucky, Lexington, ²Alltech, Inc..

Eighty-four Angus x Beefmaster cow/calf pairs were randomly allotted to eight, 10.5-ha, endophyte-infected (>90%) tall fescue pastures on May 6. The objective was to determine production responses to a daily supplement of 0, 10, 20, or 40g FEB-200(tm) (modified glucomannan, Alltech, Inc., Nicholasville, KY) carried in 0.45 kg/hd ground shelled corn (group-fed) until calves were weaned on October 28. Cows averaged 5.4 yr, 500 kg, and 5.6 body condition score (BCS) on May 6. Initially, calves averaged 109 kg at 74 d of age. Interim weights, BCS, and rectal temperatures of cows and weights of calves were taken at 35-d intervals. Cows in 0, 10, 20, and 40 g treatments lost 12, 16, 10, and 4 kg/hd (Linear, $P < 0.10$), respectively, from May 6 to July 15, but gained 44, 36, 49, and 52 kg/hd from July 15 to October 28. Total gain (May 6 to October 28) increased linearly ($P < 0.01$) as level of supplementation increased. Period BCS changes were nonsignificant, but overall BCS (May 6 to October 28) increased linearly ($P = 0.06$) as level of FEB increased. Rectal temperature change from May 6 to October 28 was greatest for 0 and least for 40 g FEBhd⁻¹d⁻¹ (Linear, $P < 0.01$). Calf gains were 63, 56, 57, and 65 (Quadratic, $P < 0.10$) from May 6 to July 15 and 98, 91, 92, and 99 kg/hd (NS) from July 15 to October 28. Overall calf gain response was quadratic ($P = 0.07$). Tympanic temperatures, monitored at 30-min intervals from July 21 through 24 in two pre-designated cows per pasture, were 38.5, 38.2, 38.6, and 38.4 °C (Cubic, $P = 0.08$) for 0, 10, 20, and 40 g FEB. Temperatures of the same cows, measured from August 22 through 25, were 38.7, 38.2, 38.3, and 38.4 °C (Quadratic, $P < 0.05$). These results demonstrate weight gains of cow/calf pairs grazing endophyte-infected fescue can be increased by supplementing with 40 g FEBhd⁻¹d⁻¹ even though body temperatures are not decreased.

Key Words: Fescue, Production, Cows

808 Birth season, preweaning stocking rates and sex effects on birth-to-harvest growth and carcass composition of Simmental-sired calves. F. M. Rouquette^{*1}, G. Estefan², J. W. Turner², and D. P. Hutcheson³, ¹Texas Agricultural Experiment Station, Overton, ²Texas A&M University, College Station, ³Texas Agricultural Experiment Station, Amarillo.

Growth and carcass data were collected during a 5-year period from 375 fall-born and 160 winter-born $\frac{1}{2}$ Simmental x Hereford x Brahman calves reared at TAMU-Overton to quantify effects of birth season (fall vs. winter), preweaning stocking rates, sex of calf, backgrounding method and feedlot performance on calf performance from birth-to-harvest and carcass characteristics. Calves were grazed at 3 levels of forage mass (stocking rates, SR) preweaning and then sent directly to feedlot or backgrounded on either bermudagrass or rye-ryegrass pasture before entering the feedlot. All calves were fed in Pinpointers at TAMU-Amarillo prior to being harvested at a commercial packing facility. Fall-born calves grazed on low SR weaned heaviest, 305 kg, and winter-born calves grazed on high SR weaned lightest at 216 kg ($P < .05$). Differences in weaning weights between steers and heifers were greater

for fall-born (291 vs. 278 kg) than for winter-born calves (251 vs. 244 kg). Calves grazed at high SR pre-weaning exhibited compensatory gains during the stocker, backgrounding phase ($P < .01$); however feedlot ADG, gain:feed, average daily intake, and final weight of calves were not affected by preweaning SR. At termination of the backgrounding phase, winter-born calves entered the feedlot heavier (424 vs. 334 kg) and older (16 vs. 12 mos) than fall-born calves ($P < .01$). Cattle were harvested at a relatively uniform, visual backfat and thus, no major differences in carcass traits were detected due to pre-or post-weaning management. When finished to a visual backfat of $>.76$ and <1.27 cm, 65% of cattle graded USDA Select with an average USDA Yield Grade of 1.9. This sire-dam combination resulted in good growth rate of calves with high cutability and lean carcasses.

Key Words: Pasture, Stocking Rate, Cow-Calf

809 Performance of early-weaned calves grazing Tifton 85 bermudagrass and receiving three levels of supplemental concentrate. J. M. B. Vendramini^{*1,2}, L. E. Sollenberger¹, J. D. Arthington², J. B. Dubeux, Jr.¹, and S. M. Interrante¹, ¹Department of Agronomy, University of Florida, Gainesville, ²Range Cattle Research and Education Center, University of Florida, Ona.

Early weaning of calves may increase pregnancy rates of primiparous beef cows, however, there is a relatively little information on nutritional management of the early-weaned calf. The objective of this study was to evaluate the performance of early-weaned calves grazing Tifton 85 bermudagrass (*Cynodon* sp.) pastures and receiving three levels of concentrate. Calves were weaned on 6 Jan. 2003 at an average age of 84 d. They grazed annual ryegrass (*Lolium multiflorum*)-rye (*Secale cereale*) mixtures pastures until 14 May 2003, when they were moved to experimental pastures where they remained until 13 Aug. 2003. Three levels of supplementation (1.0, 1.5, and 2.0% BW; 14 and 72% CP and TDN, respectively) were evaluated in a completely randomized design. Experimental units were 0.15-ha pastures, each divided into three paddocks for rotational stocking (7-d grazing and 14-d rest period). Two calves were assigned as testers to each pasture, and additional animals were used to maintain a similar herbage allowance. Every 21 d, calves were weighed and grazing time during daylight was recorded. Herbage mass was measured every 21 d using the disk plate meter methodology. Hand-plucked samples were collected every 21 days and were analyzed for CP and in vitro OM digestibility. Calf ADG (0.54-0.72 kg), stocking rate (10.6-14.2 AU/ha) (AU = 500kg LW), and gain per hectare (1100-1780 kg) increased linearly ($P < 0.10$) as supplementation rate increased. There was no variation ($P > 0.10$) in forage CP and in vitro OM digestibility among treatments but there was a linear decrease ($P < 0.01$) in herbage allowance as supplementation rate increased. Average grazing time decreased linearly ($P < 0.05$) from 274 to 206 min/d as supplementation rate increased from 1.0 to 2.0%. Based on our initial studies, increasing the amount of supplement fed to early-weaned calves increases animal performance and pasture stocking rate, but the economics of its use depend upon supplement cost and calf prices.

Key Words: Calves, Tifton 85, Supplement

PSA-Nutrition: Amino Acids

810 Comparison of methionine sources based on an equimolar trial design with broiler chickens in Brazil. S. Vieira¹, D. Hoehler^{*2}, A. Lemme², A. Kessler¹, S. Pophal¹, A. Ebert¹, and G. Eichner¹, ¹Federal University of Rio Grande del Sul, Brazil, ²Degussa Corporation, Kennesaw, GA.

Methionine is the first limiting amino acid in commercial poultry diets and is commonly supplemented as DL-methionine (DL-Met, 99%) or liquid DL-methionine hydroxy analog-free acid (MHA-FA, containing 88% of active substance). Some controversy still exists about the proper trial design and statistics which should be applied in trials comparing the two sources. In the present trial, 2730 male day-old Ross 308 broilers were fed a commercial starter diet until day 6. From day 7 to 40, chicks

were assigned to 13 dietary treatments housed in floor pens receiving corn/soybean-based diets supplemented with DL-Met (0.030 / 0.06 / 0.10 / 0.14 / 0.19 / 0.24%) or equimolar levels of liquid MHA-FA (0.034 / 0.068 / 0.114 / 0.159 / 0.216 / 0.273%) in the starter (day 7-21) and grower (day 22-40) period. Basal diets were formulated to be deficient in Met but adequate in all other nutrients and energy. Each dietary treatment consisted of 6 replicates with 35 birds per pen. Broilers performed well, maximum responses of weight gain, feed conversion, and breast meat yield (% of carcass) were significantly improved by about 10% to maximum responses of 2417 g, 1.613, and 28.5%, respectively. Responses showed the Met deficiency of the basal diets. Exponential regression revealed a relative effectiveness on equimolar basis of liquid MHA-FA for weight gain, feed conversion, and breast meat yield from

7 to 40 days of age of 59% (significant), 93% (not significant), and 64% (significant), respectively. These figures correspond to relative effectiveness figures of liquid MHA-FA on a weight/weight basis of 52%, 82% and 56%, respectively. The present data agree with numerous recent data as well as with an extensive recent literature survey for broilers, which resulted in a recommended relative bioefficacy figure of 67.8% on a weight/weight basis for liquid MHA-FA for performance criteria in broiler chickens. The data also demonstrate that the trial design - weight/weight or equimolar comparison of the two methionine sources - does not affect the validity of the test.

Key Words: Broilers, Amino Acids, Methionine Sources

811 Very young turkeys utilize 2-hydroxy-4-(methylthio) butanoic acid (HMTBA) effectively as a methionine (M) source. R. Gonzalez-Esquerria, M. Vazquez-Añon, T. Hampton, T. W. York, C. W. Wuelling, and C. D. Knight, *Novus International, Inc., St. Charles, MO.*

The relative efficacy of an 88% aqueous solution of HMTBA (Alimet feed supplement, Novus International, Inc.) vs. d, l-methionine (DLM; dry 99%) as a M source was estimated in very young turkeys using a 2 x 4 factorial with a basal treatment design. A basal sorghum/soy diet deficient in M but adequate in all other nutrients was added HMTBA or DLM at various equimolar levels (0.00, 0.05, 0.10, 0.15 and 0.20 %). Each diet was fed to 8 cages of 12 BUT toms from 1 to 21 days of age. Performance was measured at 7, 14 and 21d of age. A positive response to added M source on body weight gain (BWG) and feed conversion was observed for all ages ($P < 0.01$) proving the basal diet was deficient in M. Changes in BWG closely followed those in feed intake. Performance parameters were not different between M sources at any level ($P > 0.1$). To estimate the relative efficacy of HMTBA vs DLM, BWG per data were plotted versus supplemented M intake or M level using linear regression (LIN) or fitting separate exponential curves for each source of M (EXPI). The goodness of fit of each model was tested using the Schwarz Bayesian (BIC) and the Akaike (AIC) Information Criteria. Better goodness of fit was obtained by using M intake rather than M level at all ages and for both LIN and EXPI models. Relative efficacy obtained by using M intake was 113 ± 24 , 94 ± 17 , and $99 \pm 18\%$ for LIN, and from 113 to 114%, 93 to 94%, and 99 to 100 % for EXPI for toms at 7, 14 and 21d, respectively. An improvement in the goodness of fit was obtained when using LIN rather than EXPI. It is concluded that statistically and biologically the appropriate model for testing bioefficacy should include M intake as the independent variable and not M levels. For the current data, LIN is more appropriate than using EXPI. The confidence intervals for all estimates of relative efficacy included 100% thus HMTBA is equivalent to DLM as a source of M for very young turkeys fed commercial type diets.

Key Words: 2-hydroxy-4-methylthio Butanoic Acid, Methionine, Turkeys

812 The methionine requirements of chicks and hens fed corn and peanut meal or soybean meal based diets. G. M. Pesti*, R. I. Bakalli, and J. P. Driver, *The University of Georgia, Athens.*

Dietary arginine is a known methionine antagonist. Peanut meal (PNM) is higher in arginine than soybean meal (SBM). We hypothesized that chickens fed corn and peanut meal based diets would have higher methionine (MET), or rather methionine plus cystine (TSAA) requirements than those fed corn and SBM based diets. Two identical experiments were conducted with starting broiler chicks in battery brooders to compare the Met requirements when corn and PNM or corn and SBM based diets were fed. The data presented are pooled from both experiments. Chicks fed the corn-SBM based diet performed better than those fed the corn-PNM based diet. Further, chicks fed the most deficient corn-SBM diet (0.72% TSAA) gained 503 g/16 days, compared to 639 g when the highest levels of TSAA were fed while chicks fed the most deficient corn-PNM diet (0.61% TSAA) gained 193 g/16 days, compared to 610 g when the highest levels of TSAA were fed. The results showed that chicks require approximately 0.82% TSAA regardless of the protein source fed. A six-week experiment was conducted with Leghorn hens housed 2 per cage with 4 cages per replicate and 4 replicates per treatment. Feed consumption and egg production were very similar for PNM and SBM fed hens; PNM, (84.0 ± 0.6 HDEP); SBM, (86.2 ± 0.5 HDEP). The best overall performance was by hens fed PNM with 0.15% added Met (89.5 ± 1.0

HDEP). Significant effects of Met supplementation were noted for production, egg weight and % shell. There were no significant TSAA level by protein source interactions, and the requirement was found to be $< 0.63\%$ TSAA for hens consuming 117g feed/day. Significant differences between PNM and SBM were noted for % shell, egg specific gravity and body weight change. The egg specific gravity and % shell results indicate that more study is needed on the Ca and P contents and availabilities of PNM. Reduced body weight gains from the PNM fed hens suggests that we overestimated the energy content of our PNM sample. Our hypothesis was proved incorrect: chickens fed corn-PNM based diets need the same amount of Met as chickens fed corn-SBM based diets, nothing extra.

Key Words: Methionine, Peanut Meal, Broiler

813 The response of broilers to feeds limiting in threonine in the period 7 to 21 days of age. R. M. Gous¹, S. Van Cauwenbergh², C. Relandeau², and D. J. Burnham*³, ¹University of KwaZulu-Natal, Pietermaritzburg, Natal, South Africa, ²Ajinomoto Eurolysine SAS, Paris, France, ³Ajinomoto Heartland LLC, Chicago, IL.

Two trials were conducted to measure the response of starting broilers to digestible threonine (THR). In each, a summit dilution technique was used to measure the response in protein gain and feed intake to a range of feeds limiting in THR. In all studies, three dilution series were used: the first, in each case, was designed to measure the response to digestible THR. In both trials, oil was added to each feed in the second dilution series, to ascertain whether an additional response could be obtained, particularly at the highest protein contents. In the third series in trial 1, synthetic THR was added to each diet in the series, thereby producing a more balanced protein series, where the ratio between THR and protein was higher than in the original series. This was a means of testing whether THR was the first limiting amino acid in the original dilution series. In the second trial, synthetic lysine (LYS) was added to the feeds in the third dilution series in place of THR. The results of this series would provide information on the response to diets differing in their LYS: THR ratio. The responses to THR in all five series in which THR was first limiting was similar, confirming that the addition of oil as an energy source, and L-lysine HCl as a source of lysine, had no influence on the response to dietary THR. By fitting the Reading Model to the data the coefficient of response was 55.08 mg THR/g protein gain when the three series in Trial 2 were combined, and 57.89 when all five series (Trials 1 and 2) were combined. The contents of THR in the body and feathers are about the same, i.e. 44g THR/kg protein, so it is not necessary to separate the body and feather protein when determining the response in protein gain to dietary THR. The coefficient of response obtained suggests that dietary THR was being utilised at an efficiency of $44/55.08 = 79.9\%$ in Trial 2. When the two trials were combined, the efficiency was 76.01%. The coefficient of response obtained by fitting the Reading Model to the data is of value both in estimating the amount of digestible THR required /g protein gain, as well as the efficiency of utilisation of THR during that stage of growth

Key Words: Threonine, Broiler, Amino Acids

814 Impact of L-threonine supplementation in reduced protein diets for broilers. C. Relandeau¹, L. Le Bellego*¹, J. Bartelt², F. Hutterer², R. Khidr³, and R. Leitgeb⁴, ¹Ajinomoto Eurolysine S.A.S., Paris, France, ²LAH, Cuxhaven, Germany, ³Desert Research Centre, Mataria, Egypt, ⁴University of Bodenkultur, Vienna, Austria.

A conventional diet was compared to diets with a lower content of protein and different levels of L-threonine. A total of 293 Ross 308 broiler chicks were allocated to 4 treatments with respective 4 pens each as replicates. Birds were fed a starter diet from day 0 to 21 and a grower diet until day 36. The protein level in the diets of treatment (T) 1 was 210 and 200 g/kg in the starter and grower feed, respectively and 10 g/kg lower in the diets of T2, T3 and T4. Threonine contents in T1 were 7.8 and 7.4 g/kg in the starter and grower diets, respectively. L-threonine supplementation was 0, 0, 0.4 and 0.6 g/kg, in T1, T2, T3 and T4, respectively, so that total lysine:threonine ratio amounted 100:65, 62, 65 and 70, respectively. All other nutrient contents were equal in all diets. Growth performance was recorded per pen and slaughter performance individually on all birds. 7 chickens died. Protein and fat contents in carcasses were analysed on 12 birds per treatment. Live

weight at the end of growth period was 1956, 1870, 1958 and 1970 g in T1, T2, T3 and T4, respectively. Feed conversion ratio during the experimental period was higher in T2 than in T1, T3 and T4 (2.05, 1.90, 1.90 and 1.95, respectively, $P < 0.05$). Carcass weight in T3 was higher than in T2 (1568 and 1488 g, respectively, $P < 0.05$). Breast meat weights in T3 and T1 were also higher than in T2 (361, 362 and 324 g, respectively, $P < 0.05$). The chemical composition of the carcasses was not significantly influenced by the treatments. Supplementation with 0.04% L-threonine to diets with 10 g/kg lower content of crude protein improved growth and slaughter performance of broilers up to the level of T1. A lysine:threonine ratio of 100:65 was found to be optimal for growth parameters and breast meat deposition.

Key Words: Threonine, Reduced Crude Protein, Growth

815 Amino acid requirements of laying hens. G. P. Audren^{*1}, H. L. Classen¹, K. Schwan-Lardner¹, and K. Bolton², ¹Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, ²Saskatchewan Agriculture Food and Rural Revitalization, Regina, SK, Canada.

The objective of this research was to examine the effects of dietary levels of amino acids on hen productivity and manure nutrient content. Treatments 1 through 3 provided 660, 720 and 780 mg of lysine per day, respectively through out the experiment, with diets adjusted in response to changes in feed intake. Treatment 4 delivered 780 and 720 mg of lysine per day in two 12 week phases. Hens in treatments 5, 6 and 7 were fed diets containing 660, 720 and 780 mg of lysine per kg of feed and diet levels were not corrected for changes in daily feed intake. Essential amino acids were kept at a minimum ratio to dietary lysine content in all diets. Two White Leghorn strains were used. Each treatment was replicated four times (15 hens per replication) per strain of birds. Hens were on trial from 18 to 42 wks of age and manure was collected from sample hens at 29 wks of age. Data were analysed as a 7 x 2 factorial analysis with treatment and strain as the main effects. Dietary treatments had no effect on egg production, body weight, mortality or egg shell quality. Hens fed treatments 3, 4, 6 and 7 produced larger eggs than those fed treatments 1 and 5, while hens from treatment 2 laid smaller eggs than those from treatment 3. There was no difference in the feed efficiency (total feed per egg mass) between hens fed treatments 1, 2, 3, 4, 6 and 7. Birds fed treatment 5 had similar feed efficiency to those fed treatment 1, but were significantly more feed efficient than birds fed other diets. Total nitrogen content of the feces was not affected by dietary treatment or hen strain. The results suggest that until 42 wks of age, based on egg size, hens require 780 mg of lysine per day. However, when based on feed efficiency, hens require only 660 mg of lysine per day.

Key Words: Egg, Amino Acid, Manure Nitrogen Content

816 A comprehensive summary of experiments to define factors that may affect the gain response to 2-hydroxy-4 methylthio butanoic acid (HMTBA) and dl-methionine (DLM) in broilers. M. Vazquez-Anon^{*1}, D. D. Kratzer², R. Gonzalez-Esquerria¹, G. F. Yi¹, and C. D. Knight¹, ¹Novus International, Inc., St. Louis, MO, ²E-SCI, Olivet, MI.

A survey of available publications was done by accessing NERAC and Novus databases from 1950 to 2003. The criteria for study selection were that both HMTBA (Alimet feed supplement and MHA feed supplement, Novus International, Inc.) and DLM (dry 99%) were present, weight gain was recorded, methionine (M) addition, age of birds and duration of study were defined, and a control treatment was present. Of 80 references identified, 56 complied with the criteria, which contained 88 experiments with 364 observations (OBS) for HMTBA and 340 for DLM. Between 1980 and 1999, 68% of the OBS were published, 54% were generated in USA and Canada, and 33% in the EU. Males were used predominantly (75%) over mixed sex (19%) and females (4%). The age at start and end of the study averaged 7.7 and 31.10 d, respectively, and 68% OBS used battery cages and 22% fed pelleted diets. Starter and grower diets were fed in 63% of the OBS, and finisher was fed in only 22%. Average nutrient profile of the diets was 0.28 0.04% M, 0.29 0.08 % Cys, 20 2.8% CP, and 3,139 188 Kcal/kg metabolizable energy. Addition of M averaged 0.15 0.18% with a range of 0.03-2 %. The liquid and dry forms of HMTBA, and the Na and free forms of DLM were tested in 67 and 33, and 7 and 93% of the OBS, respectively. Mean gain, feed conversion (FC) and intake (FI) of control treatment were 754 715 g, 2.31 0.9, and 1614 1531g, respectively. The addition of M improved

gain, FC, and FI 20, 19, and 8%, respectively. This database can be used to study the factors affecting the M activity of these products in broilers and to help develop hypotheses for future experimentation. Summary data also indicate a need for more research to be conducted under commercial conditions with pelleted diets.

Key Words: Broilers, 2-hydroxy-4-methyl-thio Butanoic Acid, Methionine

817 Summarized experimental results demonstrate different dose responses of broiler gain to 2-hydroxy-4 methylthio butanoic acid (HMTBA) and dl-methionine (DLM) with multiple putative variables. M. Vazquez-Anon^{*1}, D. D. Kratzer², R. Gonzalez-Esquerria¹, G. F. Yi¹, and C. D. Knight¹, ¹Novus International, Inc., St. Louis, MO, ²E-SCI, Olivet, MI.

The objective was to determine if broiler gain responses to HMTBA (Alimet feed supplement and MHA feed supplement, Novus International, Inc.) and DLM (dry 99%) are different or affected differently by variables that may contribute to the overall methionine (M) response. Data from 88 controlled experiments where HMTBA and DLM were compared in the same study and the levels of addition did not exceed commercial levels of 0.3% were used to create a database. Best predicted gain models were generated for each M source using PROC REG STEPWISE procedure of SAS. R-square and CV of the final prediction models were 0.7, 38% and 0.6, 41% for HMTBA and DLM, respectively. The variables present in both M source models that positively contributed ($P < 0.05$) to the overall M response were level of M, age of bird at end of study, year of study, dietary Lys and energy, pelleted diets, antibiotics, and males. As gain of the basal diet and age at start of study increased, the gain response to M addition decreased ($P < 0.05$). The resulting models for the two M sources were different. Dietary M and CP, coccidiostats, and M source form (liquid vs dry) were only present ($P < 0.05$) in the HMTBA model. Dietary Cys, type of pen, Europe and USA-Canada were only present ($P < 0.1$) in the DLM model. The DLM model described a quadratic response that reached maximum at 0.25% addition, while the HMTBA model described a linear response that resulted in numerically higher predicted gain at 0.25% and greater. These results demonstrate that the M sources have different dose responses ($P < 0.05$). However, gain predictions for the two M source models compared under the average conditions of the database were not significantly different.

Key Words: Broilers, 2-hydroxy-4-methyl-thio Butanoic Acid, Methionine

818 Effect of dietary tryptophan on growth and stress of broiler chicks. A. Corzo^{*1}, M. T. Kidd¹, J. P. Thaxton¹, and B. J. Kerr², ¹Mississippi State University, Mississippi State, ²United States Department of Agriculture.

The need for dietary Trp and its effect on stress of broiler chicks from 0 to 20 d of age was evaluated. Ross x Ross 508 male chicks were used in two studies, a diet-validation and a dose-response study. The first study compared the titration diet (corn-soybean meal-gelatin byproduct based diet) against two corn-soybean meal control diets (marginal and high in dietary lysine). Day-old chicks were randomly distributed across a closed-curtain sided house (24 floor pens; 13 chicks/pen), and fed the experimental diets. Growth and feed intake were determined at 20 d of age. The control diets had higher BW ($P < 0.001$) and feed intake ($P < 0.001$) than the titration diet; however, feed conversion of the chicks was similar among treatments. A second study estimated the Trp needs for growth of chicks from 0 to 20 d of age. The titration diet was fed to chicks (49 floor pens, 13 chicks/pen; 7 replicates/trt) providing 0.13% total Trp to which 0.02% increments of L-Trp were supplemented to 0.25% of diet at the expense of a filler. Using regression analysis (95% of minimum or maximum response), it was determined that chicks optimized BW, feed intake and feed conversion at 0.21, 0.20, and 0.22% dietary Trp, respectively. Blood plasma free Trp displayed a sigmoidal response in agreement with live performance needs. Plasma cholesterol, heterocyte/lymphocyte ratio, high/low density lipoprotein ratio and corticosterone levels were unaffected by dietary Trp, suggesting that no stress effect was imposed with Trp deficiency. Plasma glucose increased in a linear manner with dietary Trp, perhaps as a result of adrenergic driven glycolytic events, rather than gluconeogenic events

associated with physiological stress. Present results are in agreement with current NRC (1994) recommendations of 0.20% total Trp.

Key Words: Tryptophan, Stress, Plasma Corticosterone

819 Standardized ileal amino acid digestibility in broiler nutrition. M. L. Locatelli¹, V. Ravindran², and A. Lemme¹, ¹Degussa Corporation, Kennesaw, GA, ²Institute of Food, Nutrition and Human Health, Massey University, Palmerston North, New Zealand.

Broiler diets formulated based on digestible amino acids (AA) rather than on total AA allow a more accurate prediction of animal performance. Recent evidence suggests that the determination of ileal AA digestibility is preferable to the traditional excreta digestibility method. The concept of standardized ileal digestibility (SID) as a mean of overcoming the limitations of apparent ileal digestibility (AID) estimates is proposed. The apparent ileal AA digestibility of several major raw materials for growing broilers were determined and standardized by correcting for basal endogenous losses. In the digestibility assays, each assay diet was offered ad libitum to three pens (4 birds/pen) of male broilers from 35 to 42 days of age. On day 42, the digesta was collected from the terminal ileum, pooled within a pen and, analyzed for CP, AA, and the marker (acid insoluble ash). Basal endogenous losses were estimated from five published datasets based on data generated using the enzyme-hydrolysed casein method. SID was calculated using the following formula: $SID = AID + ((\text{endogenous CP or AA losses (g/kg DM intake)}/\text{CP or AA of the raw material (g/kg DM)} \times 100))$. The SID (%) of CP, Met, Met+ Cys, Lys and Thr were: 90, 94, 90, 92, 85 for corn; 90, 91, 86, 90, 85 for soybean meal; and 65, 72, 62, 69, 62 for meat and bone meal, respectively. The strongest effect of standardization on digestibility estimates was observed for cereal grains. The difference between standardized and apparent ileal digestible AA varied 3-17 percentage points for corn and wheat, while it ranged only 1- 3 for soybean meal and meat and bone meal. Among AA, the digestibility of Thr was affected the most by standardization, due to the high concentrations of Thr in endogenous protein. Diets formulated on standardized ileal digestible AA offer better prediction of animal performance, particularly when poor quality ingredients with relatively low AA digestibility are used.

Key Words: Broilers, Amino Acids, Standardized Ileal Digestibility

820 Variations in the digestible lysine requirement of broilers due to sex, performance parameters and rearing environment. A. R. Garcia^{*1}, A. B. Batal¹, and D.H. Baker², ¹University of Georgia, Athens, ²University of Illinois, Urbana.

Three experiments were conducted with broilers to evaluate variations in the digestible lysine requirement (DLR) for body weight gain (BWG) and gain/feed ratio (GF) due to sex and rearing environment from 7 to 21 d. Chicks were sexed immediately after hatch, placed in either starter batteries or floor pens, and fed a corn-soybean meal diet with 23% CP and 3,200 Kcal ME/kg up to d 7 at which time the chicks were sorted and allocated to the experimental diets. Diets were formulated to be isonitrogenous and isocaloric, varying only in the levels of digestible lysine (DL). The DL levels used were 0.70, 0.80, 0.90, 1.0 and 1.1% in experiment 1, 0.80, 0.88, 0.96, 1.04 and 1.12% in experiment 2, and 0.89, 0.97, 1.05, 1.13 and 1.21% in experiment 3. The requirements were estimated by one slope broken-line methodology, fitting the data to a quadratic curve and determining the first point at which the quadratic response curve intersects the plateau of the one slope brokenline. Estimated requirements reported herein are based on results of broken-line analysis. When lysine was deficient the female broiler always out gained the males, but the opposite was true when lysine was adequate. In all three experiments the estimated DLR based on BWG was higher for males (0.97%) than for females (0.93%). However, the estimated DLR based of GF was either not different between males and females or was slightly higher for the females. As it has been reported previously, the estimated DLR based on GF was higher than that based on BWG for both males and females in all three experiments. The differences in the DLR according to the rearing environment were not consistent in the

three experiments, suggesting that rearing conditions have little or no effect on the DLR.

Key Words: Lysine, Sex, Rearing Environment

821 Chick responses to diets differing in essential and nonessential amino acids. C. A. Fritts*, A. Corzo, and M. T. Kidd, *Mississippi State University, Mississippi State.*

Utilization of crystalline amino acids have allowed for the reduction of crude protein in broiler diets. However, there is a point at which supplementation of all amino acids does not support adequate growth. An experiment was conducted to evaluate the effects of low protein diets adjusted for essential and nonessential amino acid content in chicks. Diets were formulated to contain NRC (1994) recommendations for essential amino acid content using corn and soybean meal of known composition. Dietary treatments consisted of a 22% high crude protein (HP) and an 18 % low crude protein diet (LP). The LP diet was then individually supplemented with Gly, Leu, Asp, Glu, Ala, or Pro to equal those values formulated in the HP diet. In addition, another dietary treatment consisted of the LP diet supplemented with all supplemented amino acids to equal those in the HP diet for a total of nine dietary treatments. For the first 5 d all chicks were fed a 23% CP diet and then fed the test diets from 5 to 21 d. Each diet was fed to 10 pens of 6 male chicks from a commercial broiler strain (Ross 308) in electrically heated battery brooders. Pen BW and feed consumption were taken at 5, 13 and 21 d. No significant differences were found between birds fed the LP diet with all amino acids added back and the HP diet for BW gain and feed conversion ratio (FCR) for 5 to 13 and 5 to 21 d. Birds fed the LP or LP diets supplemented with only one amino acid were significantly lower for BW gain and FCR from 5 to 13 d. Feed intake was not affected by dietary treatments. Addition of individual amino acids to LP diets had variable effects on BW gain and FCR for all age periods measured. Results of this study suggest that chicks fed LP diets should meet all essential and nonessential amino acid needs to equal performance of birds fed the HP diets. Although the combined response of all amino acids added back to the LP diet was best, 5 to 21 d live performance responses were improved by the addition of Gly, Leu, and Asp.

Key Words: Crude Protein, Amino Acids, Broiler

822 Effect of dietary lysine and stock density on broiler performance and breast meat quality. C. Berri¹, C. Relandeau², L. Le Bellego^{*2}, and M. Picard¹, ¹INRA Station de Recherches Avicoles, Nouzilly, France, ²Ajinomoto Eurolysine S.A.S., Paris, France.

Responses to increased dietary lysine concentrations were evaluated on 1584 Ross 308 male broilers between 21 and 42 days of age housed according to two bird densities. The experimental design comprised 8 factorial treatments : 2 bird densities (22 or 44 broilers / 2 m²pen) x 4 lysine levels (0.95%, 1.05%, 1.15% and 1.25%). There were 6 repetitions per experimental treatment. Birds were weighed individually at day 21 and 42. Feed consumption was recorded per pen. Body weight gain and feed conversion were calculated over the experimental period. 384 broilers were dissected at 42 days of age (48 per treatment). Final pH and water losses were measured on the pectoral muscle. Density adversely affected feed intake (169 ± 1 and 160 ± 1 g/b/d with 22 and 44 birds per pen, respectively, P<0.05), growth rate (97.4 ± 0.5 and 91.0 ± 0.7 g/b/d, P<0.05) and feed conversion (1.730 ± 0.008 and 1.760 ± 0.006, P<0.05). Except for feed intake, there was no interaction between the effects of bird density and dietary lysine. An increase in dietary lysine from 0.95% to 1.05% resulted in an increased growth rate (91.8 ± 1.6 and 95.5 ± 0.8 g/b/d, P<0.05), reduced feed conversion (1.783 ± 0.008 and 1.742 ± 0.009, P<0.05) and increased breast meat yield on body weight (17.1 ± 0.1 and 17.7 ± 0.1 %, P<0.05). Performance and body composition traits were not significantly improved for concentrations of lysine higher than 1.05%. However, final breast pH was linearly increased from 0.95% (5.91 ± 0.01) up to 1.15% (6.02 ± 0.01) lysine in the diet and water losses tended to be correlatively decreased (1.10 ± 0.06 and 0.85 ± 0.03 %, P<0.05). This result opens new ways of research for the definition of an amino acid requirement and on metabolic pathways involved in variations of breast muscle pH.

Key Words: Lysine, Growth, Meat Quality

823 Efficacy of vitamin D source and level on performance and bone mineralization of broilers fed dietary treatments for six weeks. D. R. Ledoux*¹, J. N. Broomhead¹, D. R. Campbell², J. W. Wilson², and N. E. Ward², ¹University of Missouri, Columbia, ²DSM Nutritional Products, Inc., Parsippany, NJ.

A floor pen study was conducted to determine the efficacy of vitamin D source and level on performance and bone mineralization of broilers fed dietary treatments for six weeks. Dietary treatments included: 1) Basal diet supplemented with NRC recommended levels of vitamin D₃ (200,000 ICU/ton); 2) Basal plus 2.5 million ICU (MICU) D₃ /ton; 3) basal plus 2.5 MICU D₃/ton plus 62.5 mg Hy-D/ton; 4) basal diet plus 5 MICU D₃ /ton diet; and 5) basal plus 62.5 mg Hy-D/ton diet. Diets were fed from day 1 to 42, and nutrient concentrations were adjusted at the end of week 3 according to NRC recommendations. Four replicate pens of 20 chicks were fed each treatment from day 1 to 21. On day 21, 6 chicks from each pen were removed for sampling, leaving 4 replicate pens of 14 chicks from day 21 to 42. Compared with chicks fed diet 1, chicks fed all other treatments consumed more feed and gained more weight ($P < 0.05$) at both weeks 3 and 6. Feed intake and body weight gain were similar ($P > 0.05$) for chicks fed treatments 2 - 4 at both weeks 3 and 6. Feed conversion was not affected ($P > 0.05$) by dietary treatments at either week 3 or 6. Compared with chicks fed diet 1, chicks fed all other treatments had a higher ($P < 0.05$) percent tibia ash at week 3, whereas at week 6, chicks fed diets 1 and 5 had a lower ($P < 0.05$) percent tibia ash compared with other dietary treatments. However, on an absolute bone ash weight basis (mg bone ash), bone ash was not affected ($P > 0.05$) by dietary treatments at either week 3 or 6. Bone breaking strength was also not affected ($P > 0.05$) by dietary treatments at either week 3 or 6. Results indicate that supplemental vitamin D₃ above NRC recommendations was effective in improving chick performance and bone mineralization, and 62.5 mg Hy-D/ton feed was as effective as industry vitamin D₃ levels in improving chick performance.

Key Words: Vitamin D, Bone Ash, Broilers

824 Influence of large doses of vitamin C on performance, plasma and bone calcium and phosphorus, bone characteristics and egg quality of local Dandarawi hens exposed to cold stress. M. M. Metwally*, Department of Animal and Poultry Production, Assiut University, Assiut, Egypt.

An experiment was conducted to investigate the effect of large doses of dietary vitamin C (0 to 2,000 ppm) on performance, plasma calcium and phosphorus, bone characteristics and egg quality of Local Dandarawi Hens exposed to low environmental temperatures in Winter season (December, January and February) of upper Egypt. A total of 192 local Dandarawi hens (32 wks of age) were fed diets containing vitamin C (ranging from 0 to 2,000 ppm) for 4 months. Body weight changes, egg production, weight, egg quality and bone characteristics were determined. Plasma and tibiae were analyzed for total calcium and phosphorus. Results indicated that body weight loss and mortality rate (%) were significantly ($P < 0.05$) lower in groups fed high doses of vitamin C. Egg laying rate (%) was significantly ($P < 0.05$) higher by 20% during the period of cold stress in birds fed the highest level of vit. C than control birds. Egg weight increased up to 6% and egg specific gravity was improved in hens fed 2000 ppm of vitamin C which also had increased calcium and phosphorus in the bone and blood plasma. Egg quality criteria was enhanced by high dose of vitamin C. Improved in both feed consumption and feed conversion with groups fed the highest level of vitamin C. Results recommend that large doses of vitamin C in the diets of laying hens influence calcium metabolism, affecting bone and shell mineralization and improved egg production and quality of laying hens under cold stress.

Key Words: Laying Hens, Performance, Vitamin C

825 Litter quality and feet dermatitis with broilers in response to corn-soybean vegetarian feeds. G. Eichner, S. L. Vieira*, R. P. Ott, E. S. Viola, and J. G. Almeida, UFRGS, Porto Alegre, RS, Brazil.

Europe and Saudi Arabia require that broiler grown for their market are not fed animal by products. The so called vegetarian feeds are largely formulated with an increased inclusion of soybean meal, which usually

leads to increased excreta viscosity. An experiment was designed with 8 treatments: four ingredient formulation varying in ingredient inclusion and optimizing or not the dietary electrolyte balance (DEB) to 250 meq/kg of feed. Feed treatments were: corn and soybean meal, corn and soybean meal plus a commercial pectinase + beta glucanase, inclusion of poultry by-product, inclusion of corn gluten meal. Feeds did not have any growth promotant. Birds were fed ad libitum to 42 days of age in floor pens having bell drinkers. At the end of the study birds receiving the feed with corn gluten meal had a significantly reduced body weight, but feed conversion was not affected by any treatment. Optimization of DEB did not affect any live performance response. Birds showing feet dermatitis at 21 days were tagged and lesion scores for feet dermatitis were weekly performed afterwards. These lesions were clearly intensified through the end of the study with birds fed diets with corn gluten meal demonstrating a significant reduction. Increasing diet DEB led to higher lesion scores at 21 days of age with no difference between the treatments afterwards. Lesion scores were positively correlated with the moisture of litter.

Key Words: Vegetarian Feeds, Broiler Litter, Feet Dermatites

826 Effects of salmonella typhimurium lipopolysaccharide challenge on the performance and zinc metabolism in laying hens supplemented with zinc from different sources. T. Cheng*, Y. Guo, and J. Yuan, College of Animal Science and Technology, China Agricultural University, Beijing, P.R. China.

The study was conducted to determine the effects of *Salmonella Typhimurium* lipopolysaccharide (LPS) challenge on egg-laying performance, inflammatory response, and zinc metabolism in layers fed diets supplemented with organic or inorganic zinc since 3-week-old. The three dietary treatments were corn-soybean meal basal diet without supplemental zinc or with zinc at 60 mg/kg from ZnSO₄ or zinc amino acid complex (ZnAA). At the age of 58-week-old, twelve hens from each treatment were allotted into two sub-groups. On day 1, 3, 5, 7 of the 58th week of age, six birds of one sub-group were injected intraperitoneally with LPS or sterile saline. Neither effect of zinc source/LPS challenge interaction nor zinc source on egg production performance was observed. LPS-challenge decreased egg production ($p < 0.04$) and increased percentage of cracked eggs ($p < 0.01$). With LPS challenge, the fever response of hens fed ZnAA tended to peak and subside also earlier than fed ZnSO₄ or basal diet, serum IL-1 level at 3-h was higher ($p < 0.01$), but lower at 12 h post-challenge ($p < 0.001$) in hens fed ZnAA than ZnSO₄. In saline-injected groups, serum IL-1 was higher in hens fed ZnAA than the basal diet at 3-h post-injection ($p < 0.01$). LPS-challenged birds had lower serum zinc and higher zinc sequester in liver and spleen ($p < 0.001$). Supplementation of 60mg/kg zinc from either ZnAA or ZnSO₄ significantly ($p < 0.05$) elevated metallothionein (MT) concentrations in liver and spleen. MT concentration in liver of birds fed ZnAA was higher than fed ZnSO₄ ($p < 0.05$). The magnitude of increase of hepatic and splenic MT due to LPS challenge were higher by supplementation of ZnAA than ZnSO₄. The results suggest that zinc amino acid complex enhances MT synthesis and zinc sequester in hepatic and splenic tissues, and increases the sensitivity of immune response due to LPS challenge.

Key Words: Laying Hens, Lipopolysaccharide, Zinc Metabolism

827 Effects of broiler strain on nonphytate phosphorus requirement. M. E. Persia* and W. W. Saylor, University of Delaware, Newark.

With yearly improvements in genetic stock and recent pressure to reduce safety margins of nonphytate phosphorus (nPP) in poultry feed, it is important to revisit strain differences in the nPP requirement of broiler chicks. Experiments were conducted to determine if broiler strain affects the nPP requirements of growing chicks. One-day-old Ross 308 and 708 chicks were obtained from a local commercial hatchery. Chicks utilized in both experiments were from breeder flocks of similar age that received the same level of dietary nPP. Chicks were maintained on a standard starter diet until 8 days of age, when chicks were sorted, wing-banded and randomly assigned to experimental treatments. Chick weight gain and feed intake were measured from 8 to 22 d of age. Chicks were then euthanized by cervical dislocation and the right tibia was harvested to determine fat-free tibia ash. Treatments were arranged utilizing a six by two factorial design. Experimental diets formulated to contain one

of six levels of nPP (0.13, 0.21, 0.29, 0.37, 0.45 or 0.53%) were fed to the two strains of broiler chicks. One hundred forty-four chicks of each strain were randomly assigned to six replicate groups of four chicks for each experimental treatment. Both dietary nPP level and broiler strain significantly affected weight gain and feed intake, but no interaction between the two factors was observed. Broken-line regression analysis resulted in requirement estimates of 0.33 and 0.30% for weight gain and 0.33 and 0.33% for feed intake for Ross 308 and TP7 chicks, respectively. There appears to be little difference in the NPP requirements of the two broiler strains utilized in this experiments.

Key Words: Nonphytate Phosphorus Requirement, Broiler, Strain

828 Plasma and tissue selenium and plasma glutathione peroxidase concentrations of broilers fed a selenium-deficient diet following a selenium-loading period. R. L. Payne* and L. L. Southern, *Agricultural Center, Louisiana State University, Baton Rouge.*

An experiment was conducted to compare plasma glutathione peroxidase (pGPX3) and plasma and tissue Se concentrations in broilers fed a Se-deficient diet after having been fed diets supplemented with either sodium selenite (SS) or Se-enriched yeast (SY). Female broilers were assigned to three treatments on d 0, and the trial lasted 22 d. The treatments were: 1) a corn-soybean meal diet without Se supplementation (C-SBM), 2) C-SBM + 0.30 ppm Se from SS, and 3) C-SBM + 0.30 ppm Se from SY. Each treatment was replicated eight times with 15 broilers per replicate, and these treatments were fed from d 0 to 10 posthatching. On d 10, all broilers were fed a Se-deficient diet, which consisted of cornstarch (25%), dextrose (25%), SBM (31%), and torula yeast (10%). Baseline concentrations of plasma and tissue Se and pGPX3 were established using 10 broilers on d 0. On d 10, 13, 16, 19, and 22, three broilers per replicate were randomly selected for plasma and tissue collection. Any significant effects listed are significant at $P < 0.05$. Diet did not affect growth performance during the Se-loading period (d 0 to 10) or overall (d 0 to 22). Broilers fed either SS or SY had similar pGPX3 concentrations on d 10 and 13, but the broilers fed SY had higher pGPX3 activities than those fed SS on d 16, 19, and 22. Both sources of Se resulted in higher pGPX3 and plasma Se concentrations than broilers fed the C-SBM without Se supplementation. Broilers fed SY had higher plasma Se than those fed SS except for d 10 and 22. Liver Se concentration was higher in broilers fed SY on d 10, 13, and 16 compared with those fed SS, but it was similar on d 19 and 22. Similarly, breast Se concentration was higher in broilers fed SY on d 10, 13, 16, and 19 compared with those fed SS, but it was similar on d 22. These results indicate that organic sources of Se are deposited at a greater rate in tissues, and then better utilized for maintaining pGPX3 concentrations over time than inorganic forms of Se.

Key Words: Broiler, Glutathione Peroxidase, Selenium

829 Validation of a selenium-deficient diet for broilers. R. L. Payne* and L. L. Southern, *Agricultural Center, Louisiana State University, Baton Rouge.*

Two experiments (EXP) were conducted to develop a Se-deficient diet that could be used for selenium-dependent plasma glutathione peroxidase (pGPX3) assays in broilers. For each EXP, 288 female broilers were weighed, wingbanded, and allotted to dietary treatment on d 0, and the EXP lasted 21 or 20 d, respectively. All diets were formulated to provide 1.26% total Lys, 1.0% Ca, 0.45% available P, and 3,200 kcal/kg ME. Four basal diets were used in EXP 1 and they were a corn-soybean meal diet (C-SBM), a C-torula yeast diet (C-TY), a cornstarch-dextrose-TY diet (CS-D-TY), and a CS-D-SBM + 20% TY diet (20TY). Each basal diet was supplemented with 0 or 0.30 ppm sodium selenite (SS), and each treatment was replicated six times with six broilers per replicate. The broilers fed C-SBM, regardless of Se level, had higher daily gain (ADG) and gain:feed ($P < 0.05$) than broilers fed any other diet. However, the broilers fed 20TY had similar daily feed intake (ADFI; $P > 0.05$) to those fed the C-SBM. Data from EXP 1 indicated that the best diet of these was the 20TY diet. In EXP 2, two levels of TY were used in the CS-D-SBM + TY diet. Three basal diets were used: 1) C-SBM diet; 2) CS-D-SBM + 10% TY (10TY); and 3) CS-D-SBM + 15% TY diet (15TY). Each basal diet was supplemented with 0 or 0.30 ppm SS, and each treatment was replicated eight times with six broilers per replicate. The broilers fed 10TY, regardless of Se level, had similar ADG ($P > 0.05$) as those fed C-SBM, and those fed 15TY had lower

ADG ($P < 0.05$) compared with those fed C-SBM. All broilers fed diets containing TY had decreased ADFI ($P < 0.05$) and lower gain:feed ($P < 0.05$) compared to those fed C-SBM. However, pGPX3 concentrations in the broilers were lowest in the TY diets without Se supplementation ($P < 0.05$), but they returned to levels comparable to those fed C-SBM when SS was supplemented. Therefore, a semi-purified diet containing 10% TY provides similar ADG while lowering pGPX3 activity in order to properly examine Se activity in the broiler.

Key Words: Broiler, Selenium, Torula Yeast

830 Growth performance and spontaneous bone fracture incidence of toms fed various levels of calcium and non-phytate phosphorus to heavy market weight. K. D. Roberson*, J. L. Kalbfleisch, R. A. Charbeneau, and W. Pan, *Michigan State University, East Lansing.*

This trial evaluated various dietary calcium and non-phytate phosphorus (nPP) levels fed to Nicholas 700 toms from 2 to 19 wk of age. After a two-wk brooding period, 24-25 poult/pen were allocated to 8 pens/treatment. Crumbles were fed from 2 to 5 wk of age and pellets were then fed to 19 wk of age. Treatment diets were fed in three-wk phases except for the finisher II diet which was fed for 2 wk. Diet 1 (LOW) was formulated to provide 0.50% nPP from 2-5 wk of age and matched NRC (1994) recommendations for each phase change ending with 0.25% nPP from 17-19 wk of age. Dietary calcium was kept at a 2:1 ratio with nPP for all diets. Diet 2 (MED) had formulated nPP levels that averaged 0.06 percentage units higher than the LOW diet. Diet 3 (HIGH) averaged 0.10 percentage units higher nPP than the MED diet. Diet 4 (VHIGH) was formulated according to breeder recommendations and was about 0.10 percentage units higher than the HIGH diet for dietary nPP. Body weight was reduced by the LOW diet at 5 wk of age ($p=0.009$). At 8 wk of age, BW was lower when the MED diet was fed compared to the HIGH and VHIGH diets ($p<0.001$). The LOW diet resulted in lower BW compared to the MED diet at 8 wk. Similar responses were observed the rest of the trial. Cumulative feed intake was reduced by the LOW diet at 14 wk ($p=0.001$) compared to the other diets and was lower than the HIGH and VHIGH diets at 17 and 19 wk ($p=0.001, 0.004$). Feed:gain was higher for the LOW diet compared to HIGH and VHIGH diets the whole trial. Within phase, BW gain was not significantly increased by feeding higher calcium and nPP than the MED diet in the 11-14 wk phase and the LOW diet in the 17-19 wk phase. Incidence of leg problems and spontaneous bone fractures (femur and tibia) were increased ($p=0.001$) when the LOW diet was fed compared to other diets. The HIGH and VHIGH diets resulted in the best growth performance and skeletal integrity. The HIGH diet resulted in about 3 g less nPP consumed per tom compared to the VHIGH diet with an average daily gain of 171 g/d for the trial.

Key Words: Phosphorus, Bone Fractures, Tom

831 The impact of dietary copper source and level on hen performance, egg quality and egg yolk cholesterol. P. H. Patterson¹, T. L. Cravener¹, and D. M. Hooge*², ¹*The Pennsylvania State University, University Park,* ²*Hooge Consulting Service, Inc., Eagle Mountain, UT.*

A first-cycle layer feeding trial was conducted for twelve 28d periods (October 2001 to October 2002; 18 to 66wk) using 504 Hy-Line W-36 hens in cages at 387cm²/bd initially. Three dietary treatments were: control (CON), 18.4ppm Cu; copper sulfate (CuSO₄), +125ppm Cu; tribasic copper chloride (TBCC), +125ppm Cu. There were 18 replicates of CON, 12 of each CuSO₄, and TBCC treatments all with 12 hens/replicate. Pullets were grown on corn-soy based CON, CuSO₄, or TBCC diets to 18wk, and as layers fed every pullet/hen diet combination e.g. CON/CON, CON/ CuSO₄, CON/TBCC etc. Laying hen results are reported as main effects. Egg quality measurements were taken in Periods 3, 6, 7, 9, and 12, and eggs were sampled for egg yolk cholesterol in Period 7. Better mixing was observed with the TBCC, which was non-hygroscopic, with small uniform particle size compared to CuSO₄, which had to be ground with mortar and pestle to break up large particles. For CON, CuSO₄, and TBCC fed hens, respectively, results were: final BW 1.692, 1.672, and 1.672 kg ($P = 0.34$); 12-period average hen-day egg production 74.9, 77.5, and 76.0% ($P = 0.19$); feed intake 95.6, 95.1, and 95.6 g/hen/d ($P = 0.88$); kg feed/dozen eggs 1.627, 1.555, and 1.590 ($P = 0.14$); kg feed/kg eggs 2.066, 2.049, and 2.088 ($P = 0.84$); egg weight 58.3, 58.2, and 57.9 g ($P = 0.47$); Haugh units 71.7,

78.2, and 72.2 ($P = 0.87$); and egg yolk cholesterol 1.237, 1.248, and 1.252 g/100g ($P = 0.91$). Shell weight, thickness, % shell, and albumen height means were either equal or very close by treatment. It was concluded that addition of 125ppm Cu from CuSO_4 or TBCC to the diets of first-cycle laying hens containing 18.4ppm Cu did not significantly affect hen performance or egg quality although this does not preclude the possibility that higher levels may be beneficial as shown recently by other researchers.

Key Words: Dietary Copper, Hens Eggs, Cholesterol

832 Use of 2-hydroxy-4(methylthio) butanoic acid (HMTBA) as a ligand for organic trace minerals. J. J. Dibner*, M. Trehy, C. S. Schasteen, and J. A. Hume, *Novus International, Inc., St. Louis, MO.*

Organic trace minerals (OTM) are used in animal feed to provide enhanced mineral availability compared to inorganic salts. Mineral absorption from inorganic salts is limited by their tendency to form complexes with dietary constituents like phytic acid, and by their tendency to interfere with each other when multiple salts are included in the diet. The most common OTM forms are mineral amino acid complexes (such as zinc methionine) or mineral proteinates. The latter consist of hydrolyzed protein; thus, the ligand consists of multiple amino acids, each with its own binding characteristics. HMTBA is an organic acid with a structure identical to methionine except that it bears a hydroxyl group on the alpha carbon instead of an amino group. Its mineral binding is also similar to that of methionine except that the hydroxyl group replaces the amino group in formation of the complex. Mintrex™ Zn mineral supplement is the name of the zinc complex using HMTBA as ligand. It is a 2:1 ligand to mineral complex. In the study reported here, birds were vaccinated with ADVENT® Coccidiosis Control on day of hatch and fed a zinc deficient diet ($\text{Zn} < 30$ ppm) for eight days followed by application of treatment diets consisting of the basal and four supplemented diets: zinc sulfate, Zinpro 100 and Mintrex Zn, all at a final concentration of 70 ppm supplemental zinc. Pre-challenge performance and gut morphometry were affected by vaccination ($P < .01$) and zinc source ($P < .05$). Birds were given a coccidiosis challenge by oral gavage on day 23. Performance and lesion scores following challenge were improved by zinc supplementation ($P < .05$). Post-challenge tibia zinc was affected by vaccination and zinc source with the highest tibia zinc observed in the birds that were fed Mintrex. All zinc supplemented birds had greater tibia zinc than the unsupplemented basal ($P < .01$). ADVENT is a trademark of Novus International, Inc., and is registered in the United States and other countries

Key Words: Mintrex, Zinc, Hydroxy-4(methylthio)butanoic Acid

833 Reduction of ascites mortality in broilers by dietary coenzyme Q₁₀ supplementation. A. Geng*, Y. Guo, and Y. Yang, *College of Animal Science and Technology, China Agricultural University, Beijing, P.R. China.*

One experiment was conducted to study the effects of dietary coenzyme Q₁₀ (CoQ₁₀) supplementation on growth performance and ascites in broilers. One hundred and eighty one-day-old Arbor Acre male broiler chicks were randomly allocated into 3 groups with 6 replicates each. From day 8, the diets were supplemented with CoQ₁₀ at levels of 0, 20, and 40 mg/kg, respectively. During day 15 to day 21, all the chicks were exposed to low ambient temperature (15-18 °C) to induce ascites. Feed intake, weight gain, and feed conversion ratio of the broilers during 0-6 wk were measured, mortality was recorded, and ascites was diagnosed. On day 15, 22, 29, 36, 43 and 47, blood was sampled to measure blood packed cell volume (PCV) and erythrocyte osmotic fragility (EOF) immediately. On day 22, 36, and 43, a method of right cardiac catheter was adopted to determine right ventricular pressure (RVP), pulmonary arterial pressure (PAP) and the maximum change ratio of right intraventricular pressure, and then the right ventricle and total ventricle of heart were weighed to calculate ascites heart index (AHI). The results showed that there were no significant influences observed on broilers growth performance, but the mortality due to ascites was significantly reduced by CoQ₁₀ supplementation ($P < 0.01$). 40 mg/kg CoQ₁₀ decreased EOF significantly compared with the control, but no significant changes were observed in PCV between the CoQ₁₀ supplemented birds and the control. Pulmonary arterial diastolic pressure was significantly lowered at age of 36 days, but no significant changes were observed in RVP, pulmonary arterial systolic pressure, and the maximum change

ratio of right intraventricular pressure. AHI was significantly decreased by dietary 40 mg/kg CoQ₁₀ supplementation ($P < 0.05$). The results of this study suggest that dietary supplementation of CoQ₁₀ has beneficial effect on reducing ascites mortality in broilers.

Key Words: Broilers, Ascites, Coenzyme Q₁₀

834 Comparison of growth potential and carcass components of a new strain of tom turkeys with other commercial strains. K. D. Roberson*¹, J. L. Kalbfleisch¹, and D. Dransfield², ¹Michigan State University, East Lansing, ²British United Turkeys of America.

A 19-wk trial was conducted to evaluate the growth potential and carcass component yield of a newly developed tom strain with two other major strains of commercial toms grown in the U.S. turkey industry. Hybrid Converter (HYB) poulters were smaller ($p=0.005$) at hatch than Nicholas 700 (NIC) or B.U.T.A. T2 (T2) poulters (56.7 vs. 59.8 or 59.0 g). Breeder hen wk of lay was 21 wk (HYB), 19 wk (NIC) or 6 wk (T2). Poulters were brooded at 50 toms/pen for two wk with 4 pens of HYB and NIC toms and 8 pens of T2 toms. After two wk, each pen of poulters was split to provide 32 total pens of 25 toms each. Body weight was measured at 2, 5, 11, 17 and 19 wk of age. T2 toms weighed less than other strains at 2 and 5 wk ($p < 0.001$), but were heavier at 17 and 19 wk ($p < 0.001$). T2 toms were lighter than NIC toms at 11 wk, but heavier than HYB toms ($p < 0.001$). Net cumulative feed conversion was higher for T2 toms than HYB toms at 2 wk ($p < 0.001$) and both HYB and NIC toms at 5 wk of age ($p=0.033$). There were no significant cumulative feed conversion effects in the remainder of the trial. Livability was higher ($p=0.002$) for HYB toms compared to the other strains. Mortality due to cardiovascular problems was higher ($p=0.007$) for NIC toms than the other strains. Three toms per pen were selected based upon similar BW (17.8 kg) at 17 wk and average BW in the pen at 19 wk. There was a significant ($p < 0.001$) difference in BW of toms slaughtered at 19 wk (19.3, 20.5 or 21.2 kg for HYB, NIC, or T2, respectively). Breast yield was higher ($p < 0.001$) for T2 toms than other strains at both market ages. Thigh and drumstick yield were consistently lower ($p < 0.019$) for T2 toms compared to HYB and NIC. HYB toms had lower wing yield ($p < 0.001$) and higher percent breast skin ($p < 0.001$) than other strains. There was no significant effect on lightness of breast meat. The results show that T2 toms will reach heavy (18 kg) market weight sooner with a higher proportion of meat produced as breast tissue than common commercial tom strains from other breeder companies.

Key Words: Carcass Components, Growth Potential, Tom Strain

835 Effects of cereal, heat processing, and fiber on productive coenzyme Q₁₀ and digestive traits of broilers. J. M. González-Alvarado¹, E. J. Moreno², D. G. Valencia², R. Lázaro², and G. G. Mateos*², ¹Universidad Autónoma de Tlaxcala, México, ²Universidad Politécnica de Madrid, Spain.

A battery trial was conducted to study the influence of type of cereal (60% corn or 60% rice), heat processing of the cereal (HP) (raw or cooked at 90 °C for 50 min and then rolled), and sources of fiber (none, 3% oat hulls, and 3% soybean hulls) on productivity and digestive traits of broilers from 1 to 21 d of age. Each of the twelve treatments were replicated 6 times (a cage with 14 birds). The two control diets were based on soybean protein concentrate and fish meal, and had either 2.45% (corn diets) or 1.54% (rice diets) crude fiber. In the high fiber diets, the hull source was included at expenses of an inert material. Birds and feed intake were weighed at 0, 4, 8, 13, and 21 D. Ileal viscosity and digestive organ size were measured at 21 d. From 0 to 21 d broilers fed rice had better feed conversion (FC) (1.34 vs 1.38, $P < 0.001$) than broiler fed corn. Heat processing of the cereal did not affect broiler performance at 21 d of age, but a cereal x HP interaction was detected; HP improved FC in broilers fed rice but not in broilers fed corn. Broilers fed the hull-containing diets had better FC (1.34 vs 1.39, $P < 0.01$), higher ADG (32.5 vs 30.7 g/d, $P < 0.05$), larger gizzards ($P < 0.001$), and heavier gastrointestinal tracts ($P < 0.01$) than chicks fed diets without hulls. Also, a cereal x fiber interaction was observed at 21 d; the inclusion of hulls improved FC in broilers fed rice but not in broilers fed corn. Soybean hulls but not oat hulls increased ileal viscosity at 21 d ($P < 0.05$). Rice can be used successfully in prestarter diets for chicks but no benefits are obtained from HP of corn. The inclusion of additional fiber in the diet improved chick performance, specially when low-fiber

rice diets are used, which indicates the need of a minimum of fiber in broiler diets.

Key Words: Rice, Fiber Source, Early Nutrition

Ruminant Nutrition: Beef - Digestibility & Production

836 Site and extent of digestion in beef cattle consuming restricted amounts of forage and supplemental ruminally undegradable protein. E. J. Scholljegerdes*, T. R. Weston, F. S. D'Angieri, P. A. Ludden, and B. W. Hess, *Department of Animal Science, University of Wyoming, Laramie.*

Twelve Angus-cross cattle (avg. initial BW = 594 kg \pm 44.4 kg) fitted with ruminal and duodenal cannulae were used in a 4 \times 4 Latin square double cross-over designed experiment to determine site and extent of digestion in beef cattle consuming restricted amounts of forage plus a ruminally undegradable protein (RUP) supplement. Heifers were fed chopped (2.54 cm) bromegrass hay (11.4% CP, 57% NDF) at 30, 55, 80, or 105% of maintenance. Cattle fed below maintenance were given increasing amounts of RUP supplement (6.8% blood meal, 24.5% feather meal, and 68.7% menhaden fish meal; DM basis) in an effort to equalize duodenal essential AA flow to that of the 105% of maintenance diet. Experimental periods were 21 d in length with 17 d of adaptation followed by 4 d of intensive sample collection. Total OM intake and duodenal OM flow decreased ($P < 0.001$) proportionally in cattle consuming 105 to 30% of the forage intake required for maintenance. Therefore, OM truly fermented (% of intake) did not differ ($P = 0.43$) as intake declined. True ruminal N digestibility (% of intake) tended to decrease linearly ($P = 0.07$); however true ruminal N digested (g/d) increased as intake decreased from 105 to 30%. Duodenal N flow was equal ($P = 0.33$) across intake level, even though microbial N flow declined ($P < 0.001$) as forage OM intake decreased. Due to the low ruminal degradability of the RUP supplement, non-ammonia non-microbial N flow increased ($P < 0.001$) with RUP supplementation. Post-ruminal N digested tended to increase ($P = 0.06$) with increasing levels of RUP in the diet. The increased ruminal N digested associated with supplemental RUP and restricted forage intake increased ruminal molar proportions of branched chain VFA ($P = 0.02$) and millimolar concentrations of ruminal NH_3 ($P < 0.001$). Therefore, when beef cattle consume restricted amounts of bromegrass hay, supplemental RUP can boost the supply of highly digestible N presented to the small intestine for absorption.

Key Words: Nutrient digestion, Restricted intake, Ruminal undegradable protein

837 Digestion of barley-based high-grain diets supplemented with rumen degradable and undegradable protein in steers. - digestion trial. B. W. Pamp*, M. L. Bauer, G. P. Lardy, and S. A. Soto-Navarro, *Department of Animal and Range Sciences, North Dakota State University, Fargo.*

Fifteen Holstein steers (398.2 \pm 7.3 kg initial BW) were allotted by weight to one of four dietary treatments in a completely randomized design. Objectives of this trial were to determine effects of rumen degradable (RDP) and undegradable protein (RUP) on site and extent of digestion, microbial efficiency, and ruminal fermentation. Dietary treatments were arranged in a 2 \times 2 factorial. Factors were RDP (+/-) and RUP (+/-). RDP source was urea and RUP was a combination of hydrolyzed feather meal and blood meal (80:20 on N basis). The basal diet was formulated to contain (DM basis) 83% barley, 5% alfalfa hay, 5% corn silage, 5% de-sugared molasses, 27.5 mg/kg monensin, and 11.0 mg/kg tylosin. The control diet (without added RDP and RUP) was formulated to contain a minimum of 12.5% CP, 0.7% calcium, and 0.3% phosphorus. Diets were formulated such that +RDP added 1% CP from urea and +RUP added 1% CP from the feather meal/blood meal combination. Steers were adapted to the experimental diets for 29 d before collection. Average DMI during trial period was 11.5 kg/d. Apparent ruminal OM digestibility decreased ($P = 0.05$) with RUP (41.4 vs. 35.1 \pm 2.2%). Digestibility of OM in the small intestine tended ($P = 0.09$) to increase with the inclusion of RUP (2.8 vs. 9.8 \pm 2.3%). Intake and ruminal digestibility of NDF decreased ($P = 0.01$) with the dietary addition of RUP (2.98 vs. 2.64 \pm 1.20 kg/d and 17.1 vs. 0.2 \pm 5.8%, respectively). The inclusion of RDP increased duodenal NDF flow ($P = 0.08$; 2.45 vs. 2.87 \pm 2.06 kg/d) and decreased NDF ruminal digestion

($P = 0.06$; 17.1 vs. 4.5 \pm 5.8%). The addition of RUP alone in the diet increased CP intake over control and RDP diets ($P = 0.02$; 1.62 vs. 1.79 \pm 0.07 kg/d). Total tract OM, CP, ADF, and NDF digestibilities were unaffected by RDP and RUP supplementation. These results suggest protein supplementation decreased ruminal fiber digestion and did not improve digestion of other feed fractions.

Key Words: Barley, Digestion, Ruminal Fermentation

838 Effect of choice-select spread on carcass value and profitability in early-weaned Simmental steers. N. A. Pyatt*¹, L. L. Berger¹, D. B. Faulkner¹, and P. M. Walker², ¹University of Illinois at Urbana-Champaign, Urbana, ²Illinois State University, Normal.

Early-weaned steers (n = 192, ³/₄ Simmental or greater) of known genetics were individually fed in a four-year study to determine the influence of Choice-Select (Ch-Se) spread (\$4, \$8, \$12 or \$16 per 45.4 kg) on performance and carcass factors explaining variation in carcass value and profitability. Steers were weaned at 88.0 \pm 1.1 d and fed a high concentrate diet for 334.2 \pm 0.7 d. Five-year price data were collected for feedstuffs, dressed beef, and grid premiums and discounts. Input costs included annual cow costs, veterinary, labor, feed markup, yardage and interest. Independent variables included growth and carcass EPDs, daily intake (DMI), daily gain (ADG), hot carcass weight (HCW), calculated yield grade (YG) and marbling score (MS). At \$4 Ch-Se spread, HCW (57%), YG (17%) and MS (4%) accounted for nearly 78% of the variation in carcass value among steers. ADG (27%), YG (19%), HCW (16%), MS (7%) and DMI (5%) accounted for nearly 74% of the variation in profit with a \$4 Ch-Se spread. At \$8 Ch-Se spread, HCW (55%), YG (13%) and MS (9%) accounted for over 77% of the variation in carcass value among steers. ADG (22%), MS (19%), YG (16%), HCW (11%) and DMI (4%) accounted for nearly 72% of the variation in profit with an \$8 Ch-Se spread. At \$12 Ch-Se spread, HCW (38%), MS (27%) and YG (11%) accounted for over 76% of the variation in carcass value among steers. Marbling score (26%), ADG (19%), YG (14%), HCW (8%) and DMI (4%) accounted for 71% of the variation in profit with a \$12 Ch-Se spread. At \$16 Ch-Se spread, MS (37%), ADG (16%), YG (12%) and HCW (7%) accounted for over 73% of the variation in carcass value among steers. Marbling score (33%), ADG (15%), YG (12%), HCW (6%) and DMI (4%) accounted for over 70% of the variation in profit with a \$16 Ch-Se spread. When estimating carcass value, the importance of marbling score increased while carcass weight decreased with rising Ch-Se spread. When assessing profitability, the importance of marbling score increased while ADG, carcass weight and YG diminished with increasing Ch-Se spread.

Key Words: Carcass Value, Profitability, Early-Weaning

839 Effect of dressed price on carcass value and profitability in early-weaned Simmental steers. N. A. Pyatt*¹, L. L. Berger¹, D. B. Faulkner¹, and P. M. Walker², ¹University of Illinois at Urbana-Champaign, Urbana, ²Illinois State University, Normal.

Early-weaned steers (n = 192, ³/₄ Simmental or greater) of known genetics were individually fed in a four-year study to determine the influence of base price for dressed beef (\$96, \$108, \$120 or \$132 per 45.4 kg) on performance and carcass factors explaining variation in carcass value and profitability. Steers were weaned at 88.0 \pm 1.1 d and fed a high concentrate diet for 334.2 \pm 0.7 d. Five-year price data were collected for feedstuffs and grid premiums and discounts. Input costs included annual cow costs, veterinary, labor, feed markup, yardage and interest. Independent variables included growth and carcass EPDs, daily intake (DMI), daily gain (ADG), hot carcass weight (HCW), calculated yield grade (YG) and marbling score (MS). At \$96 per 45.4 kg, MS (25%), ADG (19%), YG (18%) and HCW (10%) accounted for nearly 72% of the variation in carcass value among steers. Marbling score (19%), YG

(16%), ADG (14%) and DMI (12%) accounted for over 61% of the variation in profit when base price was \$96 per 45.4 kg. At \$108 per 45.4 kg, ADG (26%), MS (23%), YG (15%) and HCW (11%) accounted for nearly 75% of the variation in carcass value among steers. Daily gain (21%), MS (20%), YG (15%), HCW (10%) and DMI (5%) accounted for over 71% of the variation in profit when base price was \$108 per 45.4 kg. At \$120 per 45.4 kg, HCW (59%), YG (11%) and MS (10%) accounted for over 79% of the variation in carcass value among steers. Daily gain (21%), MS (20%), YG (14%), HCW (13%) and DMI (7%) accounted for over 75% of the variation in profit when base price was \$120 per 45.4 kg. At \$132 per 45.4 kg, HCW (54%), YG (9%) and MS (8%) accounted for nearly 82% of the variation in carcass value among steers. Carcass weight (52%), YG (10%), MS (9%) and DMI (7%) accounted for nearly 78% of the variation in profit when base price was \$132 per 45.4 kg. When estimating carcass value, the importance of carcass weight increased while marbling score decreased with rising base price. When assessing profit, the importance of carcass weight increased with increasing base price for dressed beef.

Key Words: Carcass Value, Profitability, Early-Weaning

840 Effects of carbohydrate source and forage level in the diet on nitrogen balance, digestibility and portal nutrient flux in sheep. A. F. Branco*, G. F. Mouro, F. J. Maia, T. F. Minella, L. P. Rigolon, and S. M. Coneglian, *Universidade Estadual de Maringa*.

The objectives of this experiment was to evaluate the effects of two carbohydrate sources (soybean hulls and corn) and two forage level (40% and 70%) in the diet on nitrogen balance, nutrient digestibility and portal nutrient flux in sheep. Were used four Corriedale wethers with 45 kg of live weight in a 4 x 4 Latin square. The wethers were fitted with catheter in mesenteric and portal veins and mesenteric artery. Digestibility and nitrogen balance were determined using total collection of feces and urine. Portal plasma flow was determined by continuous infusion of *P*-aminohippurate, and net nutrient flux was calculated as the difference between venous and arterial concentration times blood flow. There was no difference among treatments for dry matter intake, and dry matter digestibility was higher ($P < .01$) for corn diets. Intake, digestion and digestibility of neutral fiber detergent (NDF) was higher ($P < .05$) for soybean hulls diets. Corn diets showed higher ($P < .01$) ether extract intake, digestion and digestibility. There was higher ($P < .01$) non fiber carbohydrates intake and digestion in diets with 40% forage and corn diets. Energy concentration expressed as total digestible nutrients (TDN) was higher ($P < .02$) for corn diets. Diets with 40% forage showed higher nitrogen utilization as result of lower ($P < .01$) fecal and urinary losses and higher ($P < .01$) digestibility and nitrogen retention. Carbohydrate source and forage level did not influence portal plasma flow. Portal and arterial glucose concentration were higher ($P < .01$) for corn and 40% forage diets. Carbohydrate source and forage level did not affect variables related to alpha-amino-nitrogen. Portal ammonia and urea concentration, venous-arterial difference and portal ammonia flux were lower ($P < .01$) for 40% forage diets.

Key Words: Portal Nutrient Flux, Metabolism, Carbohydrate

841 Digestion characteristics of corn plus cottonseed meal compared to whole cottonseed plus de-oiled rice bran as supplements for beef cattle and the effects of extrusion. M. S. Gadberry*¹, P. A. Beck², S. A. Gunter², and D. W. Kellogg³, ¹Cooperative Extension Service, University of Arkansas, Little Rock, ²Southwest Research and Extension Center, University of Arkansas, Hope, ³Department of Animal Science, University of Arkansas, Fayetteville.

A 3 x 3 Latin-square design was used to evaluate ruminal digestion characteristics of a conventional versus co-product based supplement for growing beef cattle. Treatments included free choice hay and either 1) corn and cottonseed meal (71:29, wt:wt; CCSM) supplement, 2) de-oiled rice bran and whole cottonseed (62:38, wt:wt; DRCS), or 3) extrusion processed de-oiled rice bran plus whole cottonseed (EXT) offered at 1% BW (DM basis). Contrasts were used to compare supplement type, CCSM vs. DRCS plus EXT, and the effects of processing, DRCS vs. EXT. Neither supplement type nor processing affected marker predicted hay, supplement, or total DM intake ($P > 0.20$). Supplement DM degradation rate did not differ between type ($P = 0.82$) or processing ($P = 0.23$). Rate of passage of the CCSM (5.8%/h) supplement was higher

($P = 0.01$) than the DRCS (4.4%/h) and EXT (4.5%/h) supplements, and EXT tended to be higher than DRCS ($P = 0.08$). Supplement type ($P = 0.09$) and processing ($P = 0.08$) tended to affect supplement rumen degradable DM, 49.0, 50.4, and 52.7%, for CCSM, DRCS, and EXT, respectively. Supplement type or processing did not affect hay DM degradation rate, passage rate, or rumen degradable DM ($P > 0.10$). Supplement type tended to differ ($P = 0.06$) in rumen degradable N to rumen degradable OM (g/kg, RDN:RDOM); however, supplement type or processing did not affect ($P > 0.20$) overall diet RDN:RDOM. The total tract DM digestibility was not affected by supplement type ($P = 0.74$) or processing ($P = 0.67$) and was 68.9, 70.5, and 69.1% for the CCSM, DRCS, and EXT treatments, respectively. Co-product based supplements can effectively be used in place of conventional feedstuffs, and extrusion processing had minor effects on digestion characteristics.

Key Words: Beef Cattle, De-Oiled Rice Bran, Extrusion

842 Using a dynamic mechanistic ruminant model to estimate the effect of large changes in starch fermentation rates and site of digestion on cattle growth. B. N. Nagorcka*¹ and S. Bird², ¹CSIRO Livestock Industries, Canberra, Australia, ²University of New England, NSW, Australia.

We have observed *in vitro* fermentation rates in a range of sorghum grains and processed grains to vary over a 3-fold range. To assess the effect on cattle growth of a 2-fold change in fermentation rate, achieved by steam flaking sorghum (SF), we have used a dynamic, mechanistic model (AusBeef, supported by CSIRO) to predict feed intakes, body growth rates, body protein/fat growth rates and feed conversion ratios (FCR) in an example where a 70:30 sorghum:forage mix is fed to Angus steers at a starting body weight (BW) of 300 kg. The predictions of rumen and whole tract digestibility of starch for dry-rolled sorghum (DR) are 59% and 82%, and for SF the predictions are 78% and 97%, i.e., similar to published observations. Although 18% of the starch is predicted to be lost using DR, the cattle are also predicted (table) to eat more, and have higher BW gains in the early stages of the feeding relative to SF (found to be consistent with recent observations) because there is a shift in the site of digestion to post-rumen causing protein synthesis to be favoured. As a consequence steam flaking produces only a small reduction in the FCR relative to DR. However the FCR for SF is 10% higher (less efficient) than is predicted if all the starch escaping digestion in the rumen using DR is digested post rumen (DR+PR in the table), i.e. maximising the shift in site of digestion. It is concluded that the full commercial potential of sorghum is not achieved in SF.

		Feeding period (d)				
		1-30	31-60	61-90	91-120	1-120
DM intake (Kg/d)	SF	8.35	8.88	9.37	9.66	9.07
	DR	8.78	9.70	10.28	10.64	9.85
	DR+PR	7.91	8.41	8.94	9.39	8.66
BW gain (Kg/d)	SF	1.30	1.39	1.31	1.21	1.30
	DR	1.40	1.51	1.36	1.24	1.38
	DR+PR	1.36	1.48	1.35	1.25	1.36
Feed/gain (FCR)	SF	6.13	6.10	6.83	7.62	6.66
	DR	5.99	6.13	7.22	8.19	6.81
	DR+PR	5.55	5.42	6.32	7.17	6.08

Key Words: Cattle, Fermentation Rate, Site of Digestion

843 Ruminal nutrient degradation of untreated and chemically treated wheat grain. K.-H. Suedekum*¹, M. Klein¹, M. Paschke-Beese¹, and O. Schade², ¹University of Kiel, Germany, ²Raiffeisen HaGe Nord, Rendsburg, Germany.

This study compared ruminal nutrient degradation of untreated wheat grain (dry matter basis: 67.2% starch, 13.4% crude protein [CP]) with a wheat grain that was chemically treated with xylose in aqueous Ca-Mg lignosulphonate solution at elevated temperatures (WeiPass[®]; 55.6% starch, 14.8% CP). A standardized *in situ* procedure was applied using three ruminally cannulated steers. Feed samples were incubated in the rumens for 0, 2, 4, 8, 16, 24, 48, 72, and 336 h to estimate rate and extent (effective degradability at assumed rumen outflow rates of 2, 5 and 8%/h) of ruminal degradation of CP and starch. The proportions of ruminally undegraded CP (RUP) and ruminally undegraded starch (RUS)

were estimated as (100 - effective degradability [%]). Water-soluble fractions of CP (11.1 versus 16.7%) and starch (18.2 versus 18.4%) and lag phases before the commencement of degradation (all values < 0.5 h) were not different ($P > 0.15$) between wheat and WeiPass[®]. The sizes of the insoluble but degradable CP and starch fractions and their rates of degradation were higher ($P < 0.05$) for wheat than for WeiPass[®], and wheat was more extensively degraded ruminally than WeiPass[®], resulting in higher ($P < 0.01$) effective degradability values of CP (72 vs. 42% at 8%/h outflow) and starch (82 vs. 64% at 8%/h outflow) for wheat than for WeiPass[®]. Consequently, WeiPass[®] had RUP values which were 20 to 30 percentage units higher ($P < 0.01$) than those of ground wheat,

depending on the assumed rumen outflow rate. An increase in RUS values for WeiPass[®] compared to wheat was also observed, though not as pronounced numerically as for RUP. The RUS values of WeiPass[®] were between 10 and 20 percentage units higher than the respective values for the wheat. If the increase in RUP and RUS for WeiPass[®] above the wheat values is expressed relative to the wheat values, proportions of RUP and RUS of WeiPass[®] at an assumed rumen outflow rate of 8%/h had doubled compared with the wheat, i.e., it increased from 28 to 58% of CP for RUP and from 18 to 36% of starch for RUS.

Key Words: Rumen, Starch, Protein

Ruminant Nutrition: Dairy - Transition Cows

844 Altered feeding behavior occurs in both primiparous and multiparous Holsteins during the periparturient period. M. A. DeGroot* and P. D. French, *Oregon State University, Corvallis.*

The objective of the following experiment was to describe changes in feeding behavior during the periparturient period. Twenty-four multiparous and 18 primiparous Holstein cows were group housed and fed individually via Calan[®] doors for the three weeks before and after parturition. Behind each door was a feed tub that rested on a digital scale. Scales were connected to a computer that collected date, time, and tub weight during feeding bouts. Data were analyzed using the MIXED procedure of SAS and differences were declared significant at $P < 0.05$. During the prepartum period, total daily mealtime decreased from 227 min/d at 21 d prepartum to 130 min/d 1 d prepartum. In addition, meal duration decreased from 31 to 18 min/d, DMI decreased from 14.0 to 9.0 kg/d, and meal DMI decreased from 1.93 to 1.21 kg/meal. Meals (8.1/d) and feeding rate (81.9 g DM/min) were similar during the prepartum period. Prepartum total daily mealtime (213 and 187 min/d) and meal duration (27.2 and 24.2 min/meal) were greater for primiparous cows. Feeding rate was greater for multiparous compared to primiparous cows, 95.1 and 66.6 g DM/min, respectively. During the postpartum period, total daily mealtime and meal duration increased from 98 to 251 min/d and 15 to 29 min/meal, respectively, the day of parturition compared to 21 d postpartum. In addition, daily DMI and DMI/meal increased from 8.6 to 17.7 kg/d and 1.29 to 2.15 kg/meal, respectively. Except for the day of parturition (6.7 meals/d), meals (8.8/d) was similar during the postpartum period. Postpartum feeding rate decreased from 112.4 g DM/min the day of parturition to 85.5 g DM/min 21 d postpartum. Feeding rate was greater for multiparous compared to primiparous cows, 106.7 and 78.0 g DM/min, respectively. Results show that the depression in DMI that occurs around the time of parturition coincides with a decrease in feeding time. Therefore, strategies that increase feeding time during this critical period may be useful in increasing DMI.

Key Words: Feeding Behavior, Feed Intake, Periparturient

845 Effects of increased exposure to pre-calving diets containing BioChlor: Reproductive performance. P. J. DeGaris¹, I. J. Lean*¹, D. M. McNeill², and A. R. Rabiee¹, ¹*Bovine Research Australasia, NSW, Australia*, ²*University of Sydney, NSW, Australia.*

Holstein and Holstein x Jersey cows (n=993) in three herds, entered a prospective study to examine the effects of increased exposure to pre-calving transition diets on reproductive performance over the first 150 days of lactation. Pre-transition dry cow diets consisted of ad libitum access to ryegrass hays and pastures. Transition diets included, on a DM basis 2.8 kg ryegrass pasture, 4.2 kg ryegrass silage or creal hay, 3 kg grain or grain by-product, 0.1 kg canola or cottonseed meal, 0.6 kg BioChlor, 250 mg sodium monensin and 200 mg virginiamycin or 150 mg tylosin per day, MgSO₄ and trace elements. The transition diets contained on a DM basis (±SE), 16.0 (±1.08)% crude protein, 4.2 (±0.66)% rumen undegradable protein, 6.9 (±0.23) MJ NE_L, 0.4 (±0.06)% calcium and provided a metabolisable protein balance of 286 (±182.2) g/day and a dietary cation anion balance of -15.0 (±5.50) meq/100g. Of 158 cows excluded from analysis: 55 had gestation periods <269 or > 299 days, 58 had data missing or outside analytic limits and 45 died or were culled prior to mating start date. Cox's Proportional Hazards Model was appropriate to describe time to submission for first mating and time to conception. The probability of submission per day increased ($P = 0.021$) by 1.012 (95% Confidence Interval 1.002 to 1.023) and that

of conception per day increased ($P = 0.001$) by 1.019 (95% Confidence Interval 1.008 to 1.030) for each day of exposure to the transition diet. Increasing exposure to transition diets did not significantly increase the proportion of cows that conceived at first mating as assessed by logistic regression ($P = 0.241$). The statistical model used included farm, age, calving order and breed where significant ($P < 0.05$). The results indicate that increasing exposure to a pre-calving transition diet containing BioChlor is positively associated with improved submission of cows for breeding, a shorter time to conception, but not a significantly higher conception rate at first breeding after calving.

Key Words: Transition Diet, Sodium Monensin, BioChlor

846 Effects of increased exposure to pre-calving diets containing BioChlor: Milk production. P. J. DeGaris¹, I. J. Lean*¹, D. M. McNeill², and A. R. Rabiee¹, ¹*Bovine Research Australasia, NSW, Australia*, ²*University of Sydney, NSW, Australia.*

Holstein and Holstein x Jersey cows (n = 993) in three herds, entered a prospective study to examine the effects of increased exposure to pre-calving transition diets on milk production over the first 150 days of lactation. Pre-transition dry cow diets consisted of ad libitum access to ryegrass hays and pastures. Transition diets included, on a DM basis, 2.8 kg ryegrass pasture, 4.2 kg ryegrass silage or cereal hay, 3 kg grain or grain byproduct, 0.1 kg canola or cottonseed meal, 0.6 kg BioChlor, 250 mg sodium monensin and 200 mg virginiamycin or 150 mg tylosin per day, MgSO₄ and trace elements. The transition diets contained on a DM basis (±SE), 16.0(±1.08)% crude protein, 4.2 (±0.66)% rumen undegradable protein, 6.9 (±0.23) MJ NE_L, 0.40 (±0.06)% calcium and provided a metabolisable protein balance of 286 (±182.2) g/day and a dietary cation anion balance of -15.0 (±5.50) meq/100g. Of 182 cows excluded from analysis: 55 had gestation periods <269 or > 299 days; 82 had < six herd recordings and 45 had missing data. Cows were grouped by exposure to the pre-calving transition diet into 0 to 10, 11 to 20 and > 20 days exposure. Statistical models evaluating the association between exposure group and production variable controlled for farm, calving order, breed and age where significant ($P < 0.05$). Mean milk, protein yield, protein and fat percentage (±SE) and P values for exposure groups are tabulated below. Fat yield and individual somatic cell count did not vary significantly with exposure group. The results indicate that increasing exposure to a pre-calving transition diet containing BioChlor is negatively associated with fat and protein percentage but positively associated with milk and milk protein yields.

Exposure (days)	Milk yield (L/day)	Protein yield (kg/day)	Protein %	Fat %
0-10	28.3±0.25	0.96±0.007	3.43±0.014	3.89±0.035
11-20	28.8±0.23	0.97±0.006	3.40±0.013	3.85±0.032
>20	30.4±0.40	1.01±0.011	3.33±0.022	3.67±0.056
P value	0.001	0.003	0.004	0.008

Key Words: Transition Diet, Sodium Monensin, BioChlor

847 Effects of increased exposure to pre-calving diets containing BioChlor: Cow health. P. J. DeGaris¹, I. J. Lean^{*1}, D. M. McNeill², and A. R. Rabiee¹, ¹*Bovine Research Australasia, NSW, Australia*, ²*University of Sydney, NSW, Australia*.

Holstein and Holstein x Jersey cows (n = 993) in three herds, entered a prospective study to examine the effects of increased exposure to pre-calving transition diets on milk production over the first 150 days of lactation. Pre-transition dry cow diets consisted of ad libitum access to ryegrass hays and pastures. Transition diets included, on a DM basis, 2.8 kg ryegrass pasture, 4.2 kg ryegrass silage or cereal hay, 3 kg grain or grain by-product, 0.1 kg canola or cottonseed meal, 0.6 kg BioChlor, 250 mg sodium monensin and 200 mg virginiamycin or 150 mg tylosin per day, MgSO₄ and trace elements. The transition diets contained on a DM basis (±SE), 16.0 (±1.08)% crude protein, 4.2 (±0.66)% rumen undegradable protein, 6.9 (±0.23) MJ NE_L, 0.4 (±0.06)% calcium and provided a metabolisable protein balance of 286 (±182.2) g/day and a dietary cation anion balance of 15.0 (±5.50) meq/100g. Of 103 cows excluded from analysis: 55 had gestation periods < 269 or > 299 days, 58 had data missing or outside analytic limits. Logistic regression modelling was used to describe the risk of retained foetal membranes (RFM), clinical mastitis, lameness, CIDR use and removal from the herds, by 150 days of lactation with farm, calving order and age used as covariates where significant (P < 0.05). Increasing exposure to the pre calving transition diet did not affect the risk of lameness (P = 0.98), clinical mastitis (P = 0.16), CIDR use (P = 0.93) or RFM (P = 0.98) but did reduce the risk of removal from the herd by 150 days of lactation (odds ratio = 0.95, 95% confidence interval = 0.920 to 0.985, P = 0.004). However, time to removal was not significant (P = 0.428). The results indicate that increasing exposure to a pre-calving transition diet containing BioChlor is positively associated with improved cow survival to 150 days of lactation, but did not significantly affect other specific measures of cattle health.

Key Words: Transition Diet, Sodium Monensin, BioChlor

848 Effect of a dry propylene glycol product for postpartum Holstein dairy cows on health and performance. Y.-H. Chung^{*1}, K. S. Heyler¹, T. W. Cassidy¹, S. L. Ward¹, I. D. Girard², and G. A. Varga¹, ¹*Department of Dairy and Animal Science, The Pennsylvania State University, University Park*, ²*Probiotech International Inc., Saint-Hyacinthe, Quebec, Canada*.

Thirty-nine Holstein dairy cattle (primiparous=20 and multiparous=19) were paired by parity and previous 305ME and assigned to one of three treatments: (1) control: no propylene glycol (PG) supplementation, (2) TMR: PG supplemented in the TMR, and (3) top-dressed (TD): PG top-dressed on the TMR. Propylene glycol was supplemented at a level of 250 g/cow/d. Supplementation of PG was started after parturition and continued for three weeks after calving. Cows were fed once and milked twice daily. Dry matter intake and milk yield were recorded daily and milk was sampled weekly. Blood was sampled at 4, 7, 14, and 21 days relative to calving. Body condition score (BCS) and body weight were also recorded before and after the experiment. Supplementation of PG lowered (P<.08) blood concentration of β-hydroxybutyrate (BHBA) compared to the control. Blood concentration of BHBA for the TMR group tended (P=0.07) to be lower than the control (976.12 vs. 1627.88 μmol/L, respectively) and was not different between the TMR and TD. Blood concentrations of glucose, non-esterified fatty acid, insulin, cholesterol, urea, and aspartate amino transferase did not differ across treatments. Dry matter intake (DMI), milk yield, % of milk fat and protein, and yield of milk fat and protein were also not affected by PG treatments. However, there was a treatment by week interaction observed on DMI (P<.01) and milk yield (P<.05) indicating that DMI for the TMR increased at a more rapid rate than the control and TD and increases in milk yield for both PG treatments were greater over time as compared to the control. There was no PG effect observed on BCS and body weight change across treatments. Supplementation of PG significantly reduced blood BHBA when added to the TMR and numerically decreased blood BHBA when TD suggesting a positive benefit of providing dry PG in reducing ketosis after calving.

Key Words: Beta-hydroxybutyrate, Blood Metabolites

849 Effects of method of delivery of glycerol on performance of dairy cows during the transition period. K. L. Ogborn^{*1}, R. Paratte¹, K. L. Smith¹, P. W. Jardon², and T. R. Overton¹, ¹*Cornell University, Ithaca, NY*, ²*West Central Soy, Ralston, IA*.

Holstein cows (n=48) entering second or greater lactation were utilized to determine the effects of method of delivery of glycerol on performance of dairy cows during the transition period. Beginning 21 d before expected parturition, cows were fed either a control diet or a diet containing glycerol (5% of DM). After parturition, cows were assigned to one of four treatments in a 2 (dietary glycerol; 3.3% of DM) X 2 (glycerol drench; 500 ml/d for 5 d) factorial arrangement. From d 22 through 63 of lactation, cows were fed the same diet. Feeding glycerol during the prepartum period increased prepartum DMI (14.8 vs. 13.2 kg/d; P < 0.001). Feeding glycerol during the postpartum period tended to decrease postpartum DMI (20.9 vs. 21.9 kg/d; P < 0.08) and drenching glycerol for the first 5 d of lactation decreased postpartum DMI (20.6 vs. 22.2 kg/d; P < 0.01). Milk yield averaged 42.1 kg/d during the experiment and was not affected (P > 0.15) by feeding glycerol during either the prepartum or postpartum periods or drenching glycerol during the first 5 d of lactation. Percentages and yields of milk fat and true protein were not affected (P > 0.15) by feeding glycerol during either the prepartum or postpartum periods; however, drenching glycerol tended to decrease milk protein content (2.82 vs. 2.94%; P < 0.15) and decreased milk lactose content (4.63 vs. 4.73%; P < 0.05). Overall, feeding glycerol during the prepartum period increased prepartum DMI; however, feeding or drenching glycerol during the postpartum period decreased postpartum DMI. Milk yield during the first 63 d of lactation was not affected by either prepartum or postpartum glycerol administration.

Key Words: Transition Cow, Glycerol

850 Effects of feeding propionate and calcium salts of long-chain fatty acids on transition dairy cow performance. J. M. DeFrain^{*}, A. R. Hippen, K. F. Kalscheur, and R. S. Patton, *South Dakota State University, Brookings*.

Multiparous Holstein cows (n = 40) were used in a randomized complete block design to determine the effects of feeding Ca and Na salts (1:1, wt/wt) of propionate and Ca salts of long-chain fatty acids (LCFA) on transition performance. All cows were fed the same basal diet once daily for ad libitum intake. Treatments (kg/d) were 0.36 corn starch (C), 0.23 propionate + 0.14 corn starch (P), 0.23 propionate + 0.14 LCFA (PF1), and 0.34 propionate + 0.20 LCFA (PF2). Treatments were hand-mixed into the upper 1/3 of the TMR from 2 wk pre- through 3 wk postpartum. Intakes were recorded from 21 d pre- through 21 d postpartum. Energy density and CP were 1.54 and 1.65 Mcal/kg and 14.4 and 18.8% for pre- and postpartum diets, respectively. All cows received a common diet from 22 to 70 DIM. Milk composition was analyzed on d 7, 14, and 21. Blood was sampled at 14, 7, and 2 d prepartum and 2, 7, 14, and 21 DIM. Pre- and postpartum DMI averaged 11.9 and 16.4 kg/d, respectively, and did not differ among treatments. There was a tendency (P = 0.08) for a diet by week interaction for postpartum DMI as cows fed PF2 consumed 2 kg/d less DM during wk 2 relative to other treatments. Milk yields from 22 to 70 DIM were 48.8, 48.5, 47.8, and 51.3 kg/d for C, P, PF1, and PF2, respectively, and were not significantly affected by treatments. Milk true protein (3.32 vs. 3.16%, P = 0.05) was increased and MUN (12.5 vs. 14.4 mg/dl, P = 0.04) was decreased for C relative to other treatments. Milk fat yield from cows fed P tended to be greater than those fed PF1 (1.58 vs. 1.29 kg/d, P = 0.10). Plasma glucose, insulin, and BHBA were not affected by treatments. The PF2 treatment tended to decrease overall NEFA in plasma relative to PF1 (492 and 670 μEq/L, P = 0.08) and postpartum plasma NEFA relative to those fed PF1 (623 and 875 μEq/L, P = 0.03). Relative to PF1, feeding propionate and LCFA at the greater level in this experiment improved postpartum energy balance as evidenced by decreased concentrations of plasma NEFA.

Key Words: Propionate, Fat, Transition Dairy Cow

851 The effect of prepartum monensin supplementation on milk production in dairy cows. A. Arieli* and U. Dicken, *Hebrew University, Rehovot, Israel.*

It is commonly assumed that the effect of monensin on increasing milk yield is higher in dairy cows fed a forage based diet. A trial was conducted using 140 cows (110 multiparous and 30 primiparous) to evaluate the effect of prepartum (-30 d) administration of a monensin controlled release capsule (CRC) on production and composition of milk, and metabolites of high yielding dairy cows fed with a concentrate diet. Cows were evenly assigned, based on former yield, parity, and BCS at drying into two groups: control (CON) and CRC, supplying 300 mg monensin/d for 100 d. Primiparous cows were allocated according to BCS on -60 d. The prepartum and postpartum diets contained 14.5% crude protein and 1.55 Mcal NEL/kg of DM, and 16.5% crude protein (RUP 35% of CP), 29% NDF (forage NDF 58% of NDF), and 1.76 Mcal NEL/kg of DM, respectively. The concentrations of beta hydroxybutyric acid (BHBA) was lower and glucose concentration was higher in the CRC group, during 2 wks to +1 wk. Highest BHBA and lowest glucose concentrations were detected in +1 wk: 10.3 and 8.3 mg/dl for BHBA, and 49 and 53 mg/dl for glucose in CON and CRC, respectively ($P < 0.01$). The proportion of ketotic multiparous cows treated with a drench of propylene glycol was 11 and 34% in CRC and CON ($P < 0.05$). Milk production in multiparous cows during the first three months postpartum was 40.5 and 42.6 kg/d in CON and CRC, respectively ($P < 0.05$). Milk fat and protein concentrations were similar among treatments averaging 3.80 and 3.07% (mo 1), 3.39 and 2.88% (mo 2), 3.17 and 2.82% (mo 3), respectively. Results of the current study are in line with improved energy balance due to CRC supplementation indicating that monensin provided prepartum can be beneficial in terms of health and production when supplied to dairy cows maintained on high concentrate diets.

Key Words: Monensin, Transition Cow, Ketosis

852 Effect of lowered prepartum DCAD on urinary pH: A meta-analysis. E. Charbonneau*¹, D. Pellerin¹, and G.R. Oetzel², ¹ *Université Laval, Quebec, Canada*, ² *University of Wisconsin, Madison.*

Lowered prepartum dietary cation-anion difference (DCAD) reduces milk fever at parturition. Urinary pH has been used to directly monitor dairy cow response to lowered DCAD. A meta-analysis of previously published studies was performed to evaluate the relationship between prepartum DCAD and urinary pH. Twenty-two published studies containing 48 treatment groups met criteria for inclusion in the meta-analysis. The relationship between DCAD and urinary pH was nonlinear and fit well with a symmetric logistic curve. In the nonlinear model, treatment group mean urinary pH decreased from 8.28 to 5.99 as DCAD [(Na+K) (Cl+S)] decreased from about +100 to 150 meq/kg dry matter. Urinary pH did not change if DCAD was increased above +100 or below 150 meq/kg. Five different equations to calculate DCAD were compared to urinary pH using mixed models. The DCAD formula (Na+K) (Cl+S) was the most highly associated with urinary pH. Concentrations of dietary minerals Ca, P, Mg, Na, K, Cl and S (meq/kg basis) were also compared to urinary pH. Among these minerals, only Na, K and Cl were significant in the final model for urinary pH. Both K (0.00376) and Na (0.00339) had similar coefficients, but the coefficient for Cl (-0.00624) was about twice the magnitude. These results validate the DCAD equation (Na+K) (Cl+S) for predicting urinary pH and demonstrate the importance of Cl in lowering urinary pH of prepartum dairy cows.

Key Words: Prepartum Dairy Cows, DCAD, Urinary PH

853 Direct-fed microbial supplementation on ruminal digestion, health And performance of pre- and postpartum dairy cattle. J. E. Nocek*¹ and W. P. Kautz², ¹ *Spruce Haven Farm and Research Center, Auburn, NY* ² *Chr Hansen BioSystems, Milwaukee, WI.*

Effects of direct-fed microbial (DFM) supplementation to dairy cows during the transition period were evaluated. Forty-four Holstein cows were fed close-up and lactating diets either with or without 2 g/cow/d of DFM. The DFM contained approximately 5×10^9 cfu of bacteria (two specific *Enterococcus faecium* strains) and 5×10^9 cfu of yeast and was incorporated into the diets via a cornmeal carrier. Supplemented cows

were fed the DFM 21 days prior to expected calving date and continued through 10 wk postpartum. Cows supplemented with DFM had higher ($P < .01$) 24h ruminal DM digestibility for both corn silage and haylage than nonsupplemented cows. Supplemented cows consumed more DM during the pre- ($P < .10$) and postpartum ($P < .01$) period. In addition, those supplemented with DFM produced 2.3 kg more ($P < .01$) milk/cow/d than nonsupplemented cows. There was no difference in the 3.5 % FCM. Milk fat percentage was lower ($P < .01$), but not depressed (4.50%) for cows receiving DFM. There was no difference in milk fat or protein yield, milk protein percent and postpartum health. Cows consuming DFM had higher ($P < .05$) blood glucose postpartum, as well as lower beta-hydroxy butyric acid levels both pre- and day 1 postpartum. Plasma nonesterified fatty acid concentration was not affected by DFM supplementation. The results of this study indicate that targeted DFM supplementation positively influenced ruminal digestion of forage DM and transition cow performance.

Key Words: Direct-Fed Microbial, Ruminal Digestion, Production

854 Production and blood metabolites in multiparous Holstein and Jersey cows fed rumen-protected choline during the periparturient period. N. A. Janovick*¹, D. B. Carlson¹, J. E. Garrett², and J. K. Drackley¹, ¹ *University of Illinois, Urbana*, ² *Balchem Encapsulates, Slate Hill, NY.*

Choline is proposed to facilitate export of triglyceride from liver as VLDL, however, production responses to supplemental choline have varied. To better understand effects of choline on periparturient metabolism, our study characterized blood metabolite profiles of cows fed rumen-protected choline (RPC) pre- and postpartum. Thirty-two multiparous Holstein and 10 multiparous Jersey cows were randomly assigned to control (CON) or RPC dietary treatments. A close-up diet (1.64 Mcal NE_L/kg; 15.5% CP) was fed from 25 d before until parturition, followed by a lactation diet (1.75 Mcal NE_L/kg; 17.2% CP) from calving through 49 d postpartum. For RPC, diets were topdressed once daily with 60 g rumen-protected choline from 21 d before expected parturition through 21 d postpartum. Blood samples obtained on d -22, -19, -16, -13, -10 through 10, 13, 16, 19, 21, 28, 35, 42, and 49 relative to parturition were analyzed for urea N, total protein, BHBA, cholesterol (CH), glucose, and triglyceride in serum, and NEFA and phospholipid (PL) in plasma. RPC did not affect weekly DMI either pre- (12.1 kg; $P = .99$) or postpartum (15.3 kg; $P = .41$). Yields of milk, fat, and protein were unaffected by RPC (34.1 kg/d, $P = .39$; 1.42 kg/d, $P = .34$; and 1.07 kg/d, $P = .60$). RPC cows had lower ($P = .02$) plasma PL than CON cows at parturition (65.2 and 78.1 mg/dL). Breed*¹ treatment (b*trt) interactions affected plasma NEFA concentration d 1 to 10 postpartum ($P = .03$), urea N prepartum ($P = .05$), and BHBA postpartum ($P = .05$). A b*trt*d interaction affected CH postpartum ($P < .01$). Other metabolites were unaffected by RPC both pre- and postpartum ($P > .15$). Because milk production was not affected, cows were not over-conditioned to begin the study (BCS = 3.3), and did not lose excessive condition by 3 wk postpartum (BCS loss = 0.5), we hypothesize cows were not at great risk for accumulating fat in the liver; therefore, no effects of RPC were observed.

Key Words: Choline, Transition Period, Lipid Metabolism

855 Feeding soybeans and rumen-protected choline to dairy cows during the periparturient period and early lactation: effects on plasma lipid balance. W.A. Oelrichs*, M.C. Lucy, M.S. Kerley, and J.N. Spain, *University of Missouri - Columbia.*

This study was designed to investigate the effects of soybeans (SB) and rumen-protected choline (RPC; Reashure™ Choline; Balchem, Slate Hill, NY) fed during the periparturient period and early lactation on plasma lipid balance of dairy cows. Sixty-four Holsteins were blocked by parity and expected calving date and randomly assigned within block to one of six experimental diets. Dietary treatments were fed from 28 days prepartum to 100 days in milk. Cows were assigned to treatments in a 3 x 2 factorial arrangement. Cows received no SB, SB beginning at calving, or SB for the duration of the study. The SB were fed as raw, cracked beans at feeding rates of 1.9 and 2.8 kg DM per cow per day during pre- and postpartum periods, respectively. The RPC was top-dressed 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. Blood

samples were collected once weekly prepartum, at days 3, 0, and +3 relative to calving, and twice weekly postpartum. Plasma were analyzed for triglycerides (TG), total cholesterol, lipoprotein cholesterol and fatty acids. Changes in plasma lipid concentrations during the periparturient period were characterized for the first time. Plasma lipid concentrations were not affected by feeding rumen-protected choline. Cows fed SB beginning at 28 days prepartum had higher plasma TG, cholesterol, lipoprotein cholesterol, and fatty acid concentrations than cows fed the control diets during the prepartum period. By 14 days postpartum, cows fed SB beginning at parturition had similar plasma lipid concentrations as cows fed SB prepartum. If increased plasma lipid concentrations have reproductive advantages, feeding SB beginning 28 days prepartum as well as at parturition are equally effective in improving lipid balance during early lactation.

Key Words: Transition Cows, Lipid Profiles, Rumen-Protected Choline

856 Effects of physiological state, prepartum dietary carbohydrate source, and chromium supplementation on dynamics of insulin, glucose, and fatty acid metabolism in dairy cows. K. L. Smith*¹, M. R. Waldron¹, T. R. Overton¹, J. K. Drackley², R. C. Boston³, and M. T. Socha⁴, ¹Cornell University, Ithaca, NY, ²University of Illinois, Urbana, ³University of Pennsylvania, Kennett Square, ⁴Zinpro Corporation, Eden Prairie, MN.

Holstein cows (n=72) entering second or later lactation were used to determine whether glucose tolerance test (GTT) indices were affected by source of carbohydrate in the prepartum diet, chromium-L-methionine (Cr-Met) supplementation throughout the periparturient period, and physiological state. Cows were fed a TMR with concentrates consisting of either starch-based cereals (high NFC; 40.3% NFC) or nonforage fiber sources (low NFC; 33.6% NFC) from 21 d before expected parturition until parturition; cows were fed a common diet postpartum. The Cr-Met was supplemented once daily via gelatin capsule at dosages of 0, 0.03, or 0.06 mg of Cr per kilogram of BW^{0.75}. Thus, treatments were in a 2 (carbohydrate source) x 3 (Cr-Met) factorial arrangement. The GTT were conducted on d 10 prior to expected parturition and d 28 postpartum and on a subset (n = 13) of cows on d 5 postpartum. The GTT indices were derived using the Minimal Model and other indices were calculated using Stata. The SI (insulin sensitivity), SG (glucose effectiveness), and DI (disposition index) were lower (P < 0.001) and AIRg (acute insulin response to glucose) was higher (P < 0.001) during the prepartum period compared to the postpartum period. The lipolysis rate (FFAslope) was lower (P < 0.001) during the prepartum period. Feeding diets containing low or high concentrations of NFC during the prepartum period resulted in no significant effects on any of the kinetic indices derived from the GTT. Administering increasing amounts

of Cr-Met linearly increased (P < 0.001) AIRg. These data support the concept that increased insulin resistance during late pregnancy is mediated through decreased insulin sensitivity, and that effects of prepartum dietary carbohydrate source and Cr-Met on tissue responsiveness to insulin are modest.

Key Words: Periparturient Cow, Chromium, Glucose Tolerance Test

857 Inducing hypocalcemia in rumen fistulated steers to determine effectiveness of anionic salt treatments for transition dairy cattle. M. A. Froetschel*¹, D. Kumar¹, P. G. Smith¹, and S. N. Nichols², ¹The University of Georgia, Athens, ²West Central Soy, Ralston, IA.

Eight rumen-fistulated Holstein steers, 4 yearling (Y: 417 ± 10.4 kg) and 4 mature (M: 632.8 ± 54.6 kg), were fed a control diet (C) or three cation-anion difference (DCAD) products: Soy-Chlor 16-7 (S), Bio-Chlor (B) or Animate (A) in a replicated 4 X 4 Latin Square. Sodium bicarbonate (1%) was added to C to make it positive in DCAD. Total mixed rations, 65% concentrate and 35% chopped Bermudagrass Hay, were fed 1X/d. During experimental periods, steers were fed C for 3 d and experimental diets for 11 days. On d 13 and d 14, Y and M steers, respectively, were fit with 2 indwelling jugular catheters. In one, Na-EDTA was infused (5% wt/wt at 6.5ml/min for 5-7 h) and in the other, blood was sampled (at 30 min intervals, 2 before and 12 during EDTA infusion). Intake and urine pH (UPH) were measured daily and reticulo-ruminal motility (RRM), UPH, urine and blood ionizable-calcium (UCA and BCA) were measured before and during IV Na-EDTA infusion. Intake (DMI) and UPH decreased by feeding DCAD. DMI was 29.0, 23.9, 25.2 and 25.4 ± 1.22 kg/d, and UPH was 8.10, 6.62, 6.61 and 6.98 ± .14 for steers fed C, S, B and A. DMI as a % of BW was 2.55, 2.09, 2.25 and 2.28 ± .1. DCAD effects on BCA during EDTA infusion depended on maturity. BCA was 5.54, 5.94, 6.89 and 6.67 mg/dL ± .22 and was 57.6, 62.6, 66.1 and 65.8 ± 1.0 % of pre-infusion BCA (10.1 ± .15 mg/dL) during EDTA (2 to 5 h), for Y steers fed C, S, B and A. BCA averaged 7.17, 6.87, 5.92 and 6.58 ± mg/dL, during EDTA (2 to 5 h), for M steers and was 70.9 % of pre-infusion BCA (9.24 ± .22 mg/dL). During EDTA infusion, frequency of RRM increased in Y but decreased in M steers fed DCAD. Prior to EDTA infusion, UCA was higher in steers fed DCAD (4.38, 29.0, 29.1 and 9.41 ± 2.4 mg/dL for C, S, B and A). During the first 2 h of EDTA, UCA decreased but was still higher in DCAD steers. After 1 h of EDTA, UCA was .4, 18.8, 13.1 and .4 ± 2.4 mg/dL for steers fed C, S, B and A. After 3 h of EDTA, UCA was not detectable. Inducing hypocalcemia with EDTA, especially in yearling steers, was useful to demonstrate efficacy of DCAD products.

Key Words: Hypocalcemia, DCAD, Calcium

Swine Species

858 Gilt selection for improved lifetime productivity. J. L. Patterson*¹, G. R. Foxcroft¹, M. J. Pettitt², and E. Beltrarena¹, ¹Swine Research & Technology Centre, Edmonton, AB, Canada, ²Prairie Swine Centre Inc., Saskatoon, SK, Canada.

In a study of 509 pre-pubertal C22 and L42 (PIC Canada) gilts given direct daily boar contact from 140.1 ± 5.1 d of age, and classified with respect to age at first estrus as Early (148.0 ± 0.5 d), Intermediate (159.8 ± 0.4 d) or Late (175.7 ± 0.5 d) responders, or as Non-Responsive (NR; not cyclic by 180 d), earlier responding gilts accumulated less non-productive days (NPD) in the gilt pool (J. Anim. Sci. Vol 81, Suppl 1). Data on reproductive performance of these gilts until either culling or farrowing as third parity sows is now available to evaluate longer-term productivity. The main differences detected were between any gilt recorded as initially responding to boar contact (R) compared to NR gilts. Analyzed on the basis of overall performance of gilts originally on inventory, R were more productive than NR gilts (P #8804 0.01), as measured by the percentage of gilts successfully bred (R = 96.2 vs. NR = 75.2 %), farrowing one (R = 85.0 vs. NR = 64.2 %), two (R = 72.2 vs. NR = 49.5 %), or three litters (R = 57.6 vs. NR = 37.0 %), and as the average litters produced per gilt on inventory (R = 2.5 ± 0.1 vs. NR = 1.7 ± 0.1 litters), reflecting a lower retention rate of NR gilts in the breeding herd. When different gilt categories were compared on the basis of productivity of sows that actually produced litters, sow NPD were higher (P #8804 0.05) in NR compared to R females, as measured by average weaning-to-estrus interval (6.4 ± 0.4 vs. 5.6 ± 0.2 d, respec-

tively) and weaning-to-conception interval (11.2 ± 1.3 vs. 7.5 ± 0.6 d, respectively). In contrast, mean total pigs born per litter at first, second and third parity was not different (P #8805 0.05) between R(10.7 ± 0.4, 11.2 ± 0.4 and 12.5 ± 0.5, respectively) and NR (10.9 ± 0.2, 11.3 ± 0.2 and 12.1 ± 0.2, respectively) gilts. Gilt selection based on recorded first estrous during periods of good boar contact (heat-no-serve) is therefore predictive of better lifetime reproductive performance.

Key Words: Gilts, Selection, Lifetime Productivity

859 Efficient sows are good mothers. R. Bergsma*, IPG, Institute for Pig Genetics, AA Beuningen, The Netherlands.

Feed intake of sows during lactation is often too low. Increasing feed intake capacity of sows is one solution, increasing feed efficiency another. The aim of this study was to investigate the sources of variation in feed efficiency during lactation. Specifically, the ratio between output (energy gain of weaned and died piglets during lactation) and input (energy from feed intake and body tissue losses corrected for maintenance) was examined. Data were collected on the experimental farm of IPG in Beilen, The Netherlands. Sows were weighed and backfat was measured ultrasonically when sows entered the farrowing house and again at weaning. Piglets were weighed at birth and at weaning. Cross fostering, mortality of piglets and lactation feed intake of sows was recorded. Lactations of three sow genetic lines (CROSS) of different parities were

investigated, resulting in 250 records. The table shows that the 50% most efficient sows produced 30 % extra output at similar level of input. The relation between output and input was not linear, but of diminishing-returns. Efficient sows were better mothers because the mortality among their piglets was lower and litter weight at weaning increased. The Efficient sows had reduced feed intake and increased body tissue losses. Significance levels were estimated using the model: $Y_{ijklm} = \mu + \text{PARITY}_i + \text{BATCH}_j + \text{CROSS}_k + \text{EFFICIENCY}_l + e_m$. For the traits weight loss, piglet survival and output, a quadratic function of input was added to the model. It was concluded that sow feed intake efficiency is a trait to take into account in studies of fertility. Current work focuses on the potential to select sows with similar feed intake and body condition losses and considerably higher output in terms of survival and piglet weight gain.

	50 % Least efficient sows	50 % Most efficient sows	
Input (MJ/d)	58.4	56.0	n.s.
Output (MJ/d)	23.9	29.9	**
Net weight start lactation (kg)	235	233	n.s.
Piglet survival (%)	79.6	88.7	**
Litter weight at weaning (kg)	73.3	84.2	**
Lactation feed intake (kg)	142.2	131.3	**
Body weight losses (kg)	11.4	15.9	**

** : $p < 0.01$; n.s. not significant.

Key Words: Pigs, Lactation, Feed Efficiency

860 Comparison of different measures of carcass composition and lean growth in swine. D. W. Newcom¹, K. J. Stalder^{*1}, and G. F. Jones², ¹*Department of Animal Science, Iowa State University, Ames, IA*, ²*Department of Agriculture, Western Kentucky University, Bowling Green*.

Data from 174 pigs from two years of the Southern Kentucky Market Hog Derby Show were utilized for this study to investigate five measures of carcass composition and their impact on estimated lean growth rate. Pigs were weighed on-test at a centralized location and final off-test weights were obtained at the show. Pigs were transported to a major packing facility (Swift, Inc., Louisville, KY) for harvest. Plant employees measured midline backfat depth at the last rib location 45 m post-mortem. At 6 h post-mortem, the carcasses were ribbed and backfat was measured off-midline at the 10th rib (BF). Last rib backfat (LRBF) was measured on the split carcasses. The 10th rib loin muscle area (LMA) was traced onto acetate paper. The LMA was measured on the carcass and the tracing with a plastic grid, and on the tracing using a compensating polar planimeter. Two people made independent measurements with tolerance of 1.29 cm² permitted. Kilograms (WTL) and percent (%L) lean in the carcass and grams of lean gained per day on test (LG) were calculated from the three loin muscle area measures and the two

measures of LRBF. Data were analyzed using a linear model with treatment (method and location of measurement) and year included as fixed effects in all analyses. Off-test weight and BF were included as covariates in the LMA analysis. Off-test weight was included as a covariate in the WTL, %L, and LRBF analyses. On-test weight was included as a covariate for the LG analyses. The LMA measured directly on the carcass was the smallest of the three methods of measurement and was different ($P < 0.05$) from that measured with the polar planimeter. The grid measurement on the acetate paper was intermediate but not different from the other two measures. When estimating WTL, %L, and LG, the three measures of LMA were not different but were lower ($P < 0.05$) than those estimated from LRBF measures. In conclusion, different techniques for measuring LMA were different but had no impact on WTL, %L, or LG estimates.

Key Words: Swine, Composition, Lean Growth

861 Effects of removing different proportions of slaughter weight pigs from pens on subsequent growth performance. J. M. DeDecker^{*1}, M. Ellis¹, B. F. Wolter², and B. A. Peterson¹, ¹*University of Illinois at Urbana-Champaign, Urbana*, ²*The Maschhoffs, Inc., Carlyle, IL*.

Twenty-one pens of crossbred finishing pigs ($n = 651$) were used in a randomized complete block design to evaluate removing three different proportions (0, 10, and 20%) of the heaviest pigs from pens on subsequent performance over a 14-d period. Pens (31 pigs/pen; mean BW = 124.3 ± 1.09 kg) were randomly allocated to treatment, and the heaviest animals were removed as dictated by treatment. Floor and feeder spaces/pig were 0.69m² and 5.25cm, 0.76m² and 5.81cm, and 0.85m² and 6.50cm for the 0, 10, and 20% removal treatments, respectively. Two statistical analyses were conducted. The first compared performance of the entire groups of pigs after removal (31 vs 28 vs 25 pigs/pen for the 0, 10, and 20% removal treatments, respectively). The second analysis compared performance of the lightest 25 pigs in each treatment. ADG ($P < 0.05$; 872, 988, and 1,048 \pm 46.2g/d for 0, 10, and 20% removal treatments, respectively) and feed intake ($P < 0.001$; 2,848, 3,064, and 3,137 \pm 53.7g/d, respectively) increased linearly as the proportion of pigs removed increased. Feed efficiency was not affected ($P = 0.106$) by removal treatment. Comparing the lightest 25 pigs/pen across treatments, ADG increased linearly ($P < 0.05$; 847, 970, and 1,034 \pm 45.8g/d, respectively). The total live weight of pigs produced was similar ($P > 0.05$) across treatments (4,246, 4,256, and 4,243 \pm 37.3kg, respectively). However, the total feed consumed/pen during the study period decreased ($P < 0.001$) linearly as the proportion of pigs removed increased (1,222, 1,200, and 1,097 \pm 19.5kg, respectively). The within-pen coefficient of variation for the entire pen at d14 post-removal was similar ($P > 0.05$) among treatments (7.38, 6.73, and 6.88 \pm 0.419%, respectively). In summary, these results suggest that growth performance increases linearly as the proportion of pigs removed increases from 0 to 20%.

Key Words: Pigs, Removal, Proportions

ABSTRACTS
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SYMPOSIA AND ORAL SESSIONS

* Author Presenting Paper

Animal Health: Symposium: Integrative Aspects of Immunity, Nutrient Metabolism, and Production in Livestock

862 What are the costs of immunity? Kirk C. Klasing^{*1}, Brooke D. Humphrey¹, Alfonso J. Mireles², and Elizabeth A. Koutsos³, ¹Department of Animal Science, University of California, Davis, ²Department of Feed Research, Foster Farms, ³Department of Animal Science, California State University, San Luis Obispo.

Studies in animal nutrition often describe changes in the immune response that occur when higher levels of nutrients are added to the diet and ascribe these changes to the high needs of the immune system. Likewise, the decrease in growth and productivity that occur during an infectious challenge are normally blamed on the diversion of nutrients to support the immune response. An accounting of the costs of immunity must be accurately made for these theories and arguments to have a sound quantitative basis. Additionally, an understanding of the priority of leukocytes for nutrients is needed in order to determine susceptible populations. The costs of maintaining the immune system are related to allocating nutrients for the continued production of leukocytes, immunoglobulin, and other plasma proteins to replace those lost during normal turnover of cells and extracellular proteins. The costs of using the immune system to thwart the invasion of potential pathogens come in three primary forms. First, there are nutritional costs of mobilizing the responding cell types and fueling their effector functions. Second, there are losses in tissue function that result from damage incurred when leukocytes engage their effector mechanisms and damage tissue integrity and host cell viability (collateral damage). The primary cost of an authentic pathogen challenge is due to the systemic acute phase response, especially recruitment of the liver to aid the immune system by producing protective proteins. Third, additional costs do not appear to be related to effector functions of the immune system and include a loss of bone mass and strength, dissipation of carotenoids and increased metabolic diseases.

Key Words: Immune Response, Requirements, Maintenance

863 Interactive responses in gut immunity, and systemic and local changes in the IGF system in nursery pigs in response to *Salmonella enterica* serovar Typhimurium. B. J. Johnson^{*}, S. S. Dritz, K. A. Skjolaas-Wilson, T. E. Burkey, and J. E. Minton, Kansas State University, Manhattan.

In recent years, we've sought to understand how disparate endocrine and immune signals converge in response to *Salmonella enterica* serovar Typhimurium (ST) to impact growth and the IGF system in the nursery pig. The enteric pathogen ST interacts with gut epithelium to rapidly upregulate the chemoattractive chemokines interleukin-8 and chemokine ligand-20, and to selectively affect toll-like receptors. Activation of these components of the innate immune system appear to confine the immune response largely to the gut mucosa and mesenteric lymph nodes as evidenced by the lack of systemic elevation of proinflammatory cytokines. Despite the apparent restriction of proinflammatory signals to the gut-associated lymphoid tissue, ST provokes peripheral sequelae consistent with danger signaling, including the febrile response and activation of the adrenal axis. Also, pigs undergoing ST-induced febrile responses experience a consistent period of inappetence that is independent of changes in leptin. Additionally, this period of depressed intake is invariably accompanied by an unmistakable decline in serum IGF-I and, less consistently, with parallel reductions in circulating IGFBP-3. More recently, we have characterized changes in expression of components of the IGF system within skeletal muscle of pigs undergoing ST-associated enteric disease. Despite the characteristic decline in circulating IGF-I, relative abundance of skeletal muscle IGF-I and IGFBP-3 mRNA was unaffected by ST. However, mRNA for IGFBP-5 was reduced in skeletal muscle of ST-challenged pigs, suggesting a possible effect of the enteric disease on IGF availability. Taken together, oral challenge with ST engages elements of the mucosal innate immune system that appear to contain the spread of systemic proinflammatory cytokine signals. Even so, ST challenge is associated with parallel changes in both systemic and local IGF systems that may impact pig growth.

Key Words: IGF, Pigs, *Salmonella Enterica*

864 Protein tyrosine nitration: a membrane-organized mechanism for altered signal transduction during proinflammatory stress. T. H. Elsasser*¹, S. Kahl¹, J. L. Sartin², and C. Li¹, ¹USDA, Agricultural Research Service, Beltsville, MD, ²Auburn University, Auburn, AL.

Three constitutive isoforms of NO synthase (NOS), i.e., endothelial, neuronal, and mitochondrial (a fourth isoform being the high-output inducible form) impact physiological processes through their respective localized low-output production of NO from arginine. Their activities are regulated through specific phosphorylations and cofactor interactions. A significant feature of NO-based cellular function resides in how NO is processed in association with the prevailing redox conditions within cells. Under minor anoxic conditions where tissue pCO₂ increases, concomitant generation of NO via NOS and superoxide anion via xanthine oxidase, can lead to the condensation of these free radicals to form the highly reactive oxynitrogen anion peroxynitrite (ONOO⁻). A major intracellular target for ONOO⁻ is the phenolic ring of protein tyrosines where the attack results in the formation of nitrotyrosine. Nitrated proteins are identifiable by the immunohistochemical localization of nitrotyrosine in a growing number of acute and chronic diseases. We have shown that nutrition is capable of modulating the development of protein nitration during low-level proinflammatory stress. Nutrition regulates NO production rates as well as provides a sink to alter the interaction of NO with intracellular components and mops-up ONOO⁻ via scavenging capabilities of α - and γ -tocopherols. Most recently, however, we have identified membrane-based caveolae as sites of epitope-specific nitrations that appear to play a functional role in the acute modulation of signal transduction cascades where, e.g., the anabolic processes driven by the GH-IGF-1 axis need to be curtailed to facilitate alternative nutrient use paradigms for immunoresponse. Collectively, nutrient management of host response to immune challenge contributes significantly to how protein nitration reactions are processed and their study offers potential to develop intervention strategies to maintain animal health.

Key Words: Signal Transduction, Nitric Oxide, Nutrition

Extension Education: The Use of Electronic Media for Extension and Producer Education

866 Maximize your efficiency through online knowledge Bases. C. H. Wood* and A. S. Griffin, *University of Kentucky, Lexington.*

Internet technology has dramatically changed access to information. Technology does not determine change but encourages us to seek new solutions. Our clientele are seeking new solutions by accessing information in the fastest, most cost-efficient way online. A dynamic knowledge base that learns with each clients inquiry can provide such a solution. A knowledge base is a database of questions and answers. It is more than frequently asked questions (FAQ). FAQs are usually just text-based lists of questions and answers about a topic. A knowledge base is searchable, but has additional search options that search on keywords that don't appear in the question or answer. A self-learning knowledge base learns through seeding, capturing, organizing, and managing information. The knowledge information is published to a knowledge base, allowing users to search and find answers on their own through a Web interface. Users have the ability to search for answers to their questions based on the context of their queries. Users who are unable to find answers to their questions have the ability to submit questions. Based on clients past queries, answers are organized so the from the most most useful information moves to the top of the knowledge base ensuring that users find answers to their questions quicker. In the current Extension environment, specialists are asked to be more efficient. A quick way to become more efficient is to reduce the amount of time spent answering redundant or similar questions. The underlying factor is that these repeated questions are still important because clientele are still asking them. How can specialists better handle these similar questions and free up time to develop more effective programming while embracing new ways of information delivery? To address these issues, the Southern Region Equine Extension Specialists developed HorseQuest.info, a self-learning, client-driven knowledge base. It self-propagates based on user interaction and expert responses. In essence, the client populates the knowledge base with the most useful information to them.

Key Words: Extension, Online, Knowledge Base

865 Parturition-Induced Changes in Neutrophil Gene Expression: Implications for Cell Function. J. L. Burton*, S. A. Madsen, L.-C. Chang, P. S. D. Weber, K. R. Buckham, and P. M. Coussens, *Department of Animal Science, Michigan State University, East Lansing.*

Neutrophils (PMN) are the focus of many mastitis studies because of the critical role they play in immune defense against intramammary infections. However, physiological and molecular factors that induce functional changes in PMN during the mastitis-susceptible parturient period are unknown. In our recent immunogenomics studies we hypothesized that circulating PMN become targets of fluctuating parturient steroids, responding with altered expression of master genes that regulate the cells' innate immune activities. We used RNA from PMN of periparturient cows in cDNA microarray, DDRT-PCR, and other experiments to monitor the cells' gene expression and phenotypic profiles. Correlation analyses and in vitro experiments were performed to test possible contributions of cortisol, estradiol, and (or) progesterone to changes in these profiles. To date, the largest ontological cluster of affected PMN genes encode proteins involved in apoptosis regulation, with smaller clusters of affected genes also involved in cell trafficking, opsonic phagocytosis, oxidative metabolism, and less well studied tissue remodeling functions of the cells. Correlation analyses revealed cortisol as a probable factor in the profile changes observed at parturition, and this was largely confirmed in follow-up in vitro studies in which steroids were applied directly to isolated PMN. The nature of identified changes in gene expression and cell phenotype has led us to develop an untested hypothesis, that the surge in parturient cortisol acts to redirect PMN gene expression for extended longevity with heightened tissue remodeling capacity at the expense of their traditional but short lived bactericidal functions. Such a shift would be consistent with the documented role of PMN in cervical and placental remodeling that enables parturition to occur in humans, and may help account for mastitis susceptibility around calving.

Key Words: Neutrophil, Gene Expression, Apoptosis

867 The power of W³: delivering courses, training, and extension programs over the web. A. S. Griffin* and C. H. Wood, *University of Kentucky, Lexington.*

It's not if you build it they will come but the fact that they are already here. Sixty three percent of the U.S. population over the age of 18 is online. Over three-quarters of youth ages 12 to 17 use the Internet. By the fall of 2002, 63 million Americans (34%) used the Internet to conduct education-related research and seek training online. In addition, three out of four Internet users have searched for information related to a hobby or special interest. As the need for quality, non-biased material increases, so does the role of educators and the expectations of the resources they provide. Online learners benefit from being able to gain knowledge through multiple delivery formats: written material, streaming audio and video, interactive games and quizzes, asynchronous and synchronous dialogue, and simulated animations. These tools, delivered in an anyplace, anywhere, anytime, and any platform format, bring new life into the quality of material available to anyone. Many educators have not been trained to conduct courses or Extension programs at a distance. However, once engaging in providing educational materials online, they realize the freedom of time and reduction in redundancy from that of traditional methods. Teaching face-to-face, through written publications, instructional video, and video conferencing formats are all examples of instruction that can integrate seamlessly into online learning environments. The most traditional forms of online course delivery can be achieved through proprietary courseware offered at most universities. However, materials and modules can be successfully prepared through conventional Web sites. Advances in voice over Internet Protocol (IP) allow synchronous learning through standard 28.8 modem connections. Innovations in the use of wireless technology through wireless devices further expand learning potential. Consider the possibilities: for extension clientele and professionals, continuing education, credit, not-for credit, graduate training, and even collaborative teaching, to name a few.

Key Words: Extension, Web, Training

Goat Species: Export Potential, Market Outlook, and Value-Added Processing

868 Export potential, market outlook, and value-added processing of goat fibers. C. J. Lupton*, *Texas Agricultural Experiment Station, Texas A&M University System, San Angelo.*

Goat fiber production in the USA is examined from the perspectives of world production, export potential, market outlook, and adding value. Fibers harvested from more than 85 million goats in 12 countries make up about 0.04% of the world's annual textile fiber production. Cashmere, the fine (mean fiber diameter (MFD) less than 19 microns) undercoat combed or shorn from numerous breeds of goat, comprised about 15 million kg (mkg) of this total in 2003, whereas mohair, shorn from the Angora goat, constituted about 6.60 mkg. Only a very small amount of the cashmere (about 3,000 kg) and 0.75 mkg of the mohair were produced in the USA. Cashmere is more valuable than mohair. Commercial quotations for cashmere (dehaired Chinese white) currently range from 57to68/kg, whereas greasy mohair sold in the range 4/kg(MFDgreaterthan34microns)to18/kg (MFD 24 to 26 microns) in a recent South African sale. The small quantity of US cashmere prohibits export. In contrast, the majority of US mohair is exported, most with little or no added value. Value adding opportunities exist in post-shearing, processing, and textile manufacturing systems. These include skirting, classing, and objective measurement of the raw material before sale; scouring; dehairing (in the case of cashmere); production of sliver, yarn, and fabric (knitted or woven); end-product manufacture; wholesale; and retail. Participation in these opportunities in the USA ranges from none to all of the above. Examples of the latter are activities of the Cashmere America Cooperative and the Mohair Council of America that include retaining ownership of products all the way through retail. Participation in value adding through intermediate stages (e.g., scouring, dehairing, hand spinning, and hand knitting) is practiced by many individuals and groups throughout the country at the cottage industry level. The market outlook for both cashmere and mohair is good. Inclusion of mohair in the 2002 Farm Bill should provide growers with greater financial security through 2007.

Key Words: Goat Fibers, Cashmere, Mohair

869 Marketing slaughter goats and goat meat products. T. L. Stanton*, *Cornell University, Ithaca, NY.*

The survivability of our US meat goat industry is dependent on improving its accessibility and desirability to our consumer base. Goat meat consumption in the US has grown sharply in the last 10 years. The goat slaughter rate at USDA inspected facilities climbed from 207,893 goats in 1991 to 595,500 goats in 2002. Imports from our largest importer, Australia, increased from approximately 3 million pounds in 1990 to 17 million pounds in 2003. At 40 lbs, the largest carcass popular with most importers, this is equal to 425,000 more goats. Increased consumption is driven by the popularity of goat meat with the diverse ethnic groups that immigrate yearly to the US and also the popularity of heart-friendly, ethnic foods. However, desired goat meat products need to be readily available year round to encourage consumers and processors to continue these dietary preferences. It is counterproductive if goat meat is available only sporadically, specific carcass preferences are ignored, people are made to feel unwelcome when seeking out goat meat through established channels, or if our marketing infrastructure collapses in on itself and offers all of us fewer marketing choices. There are many marketing

strategies that producers can adopt to reap more of the market share of their goats. Almost all of these require extra investment in labor and/or capital. Educational institutions can aid meat goat producers by maintaining web-based marketing services directories to facilitate easy access to potential buyers and slaughterhouses, moderating email list serves that allow producers to group together to meet volume demands of specific markets, creating fact sheets on marketing goats through various channels, and presenting case studies on market pools, etc. Programs that help producers and buyers to find each other and arrange necessary market logistics will help maintain and expand our meat goat industry. The goat meat market is highly diverse in part because its customers and producers reflect a wide range of life styles and needs. Presently, programs that provide producers with a wide range of marketing opportunities may help the industry more than establishing a "one size fits all" marketing model.

Key Words: Goat Meat, Marketing

870 Value-added processing and consumer preference of goat meat. K. W. McMillin*, *Department of Animal Sciences, Agricultural Center, Louisiana State University, Baton Rouge.*

Value-added food products have been changed in form, function, or grouping to increase their economic value and/or appeal. Goat meat value is increased with fewer market channel steps or decreased distribution costs, in specific uniform or consistent groups, after processing into more palatable or usable forms, or when available in a different form or at a different time more highly demanded by the purchaser. The fat in primal and retail cuts from kid goats is increased with feedlot or concentrate diets, which lessens the ethnic consumer and processing market value. Value is increased with year-round availability compared with limited seasonal supplies. Meat from kid and yearling goats was not distinguishable by ethnic consumers unless the meat was from goats with low conformation. The consistent size, conformation, and characteristics of imported frozen goat meat has made it acceptable in some markets and its value is increased when shipped as wholesale or retail portions rather than as carcasses. Institutional Meat Purchase Specifications (IMPS) for goat meat provide descriptions of cuts and size uniformity. Processed meat research has been with products or with processes similar to those of other meat species. The tenderness of domestic goat meat is improved with electrical stimulation and postmortem aging of carcasses and blade tenderization of cuts. Addition of oat trim or oat bran reduced fat and shear value while tocopherol antioxidant addition improved shelf-life of goat meat patties. Smoked and fermented sausages from goat meat are acceptable, but more expensive per unit weight than sausages from other species. The emulsification capacity of goat meat proteins is high, with palatability of frankfurters increased with use of mechanically separated goat mince. Goat meat was distinguishable from other species in plain and seasoned meat loaves, chili, curries, and patties. Specific organic acids are associated with goat meat flavor and oxidized or warmed-over flavors develop more rapidly in cooked goat meat than in meat from other species. More convenient product forms and availability would increase value of goat meat to ethnic and non-traditional consumers.

Key Words: Goat, Meat, Processing

International Animal Agriculture: Animal Agriculture in Global Context

871 Setting research agendas for animal science in a global context. M. Gill* and R. Dyer, *Macaulay Institute, Craigiebuckler, Aberdeen, Scotland.*

The world is changing fast, but not homogeneously! Meat consumption in some countries is increasing rapidly, in others decreasing. World Trade is a political issue, favoured by some, rejected by others. Climate change is recognized as an urgent issue by some less by others. What does all this mean for research in animal science?

I will discuss the importance of being aware of global trends and of translating these into potential policy requirements in terms of setting research agendas. 'Thinking globally while acting locally' will be one theme. A second theme will be inter-disciplinarity. Increasingly it is recognized that policies need to be 'joined-up', water is a good example.

In Europe, the Water Framework Directive builds on a number of other policy directives and is a good example of what future policies might look like.

I will use at least 1 Case Study to illustrate how inter-disciplinary projects can be developed to meet policy needs. The Case Study is from the Philippines, where the original aim was to test the hypothesis that intensive livestock production systems inherently have more negative impacts on the environment than small-scale systems. During its implementation, the project has evolved to interest experts in water quality, economists and medics with an interest in environmental health issues in addition to animal scientists. The project has also been discussed with both people living in the communities and with policy people in government departments. I will describe the process and how

the mix of disciplines involved have added value to what is an animal production problem.

Key Words: Environment, Inter-Disciplinary, Policy

872 Today's poultry industry from a global perspective. P. Aho*, *Poultry Perspective, Storrs, CT.*

In the last 50 years the world consumption of chicken eggs increased from 5 to 10 kilos. Chicken meat consumption rose from 2.5 kilos to 10 kilos. While most people have benefited from the overall increase in poultry consumption, the distribution of these products is far from uniform. Using information from the World Bank and the Food and Agriculture Organization of the United Nations, an estimate was made of average income (purchasing power parity) and consumption of chickens eggs and meat by income quintile. The estimates demonstrate a correlation between income and poultry consumption. The future consumption of poultry products will also be influenced by income distribution. This

kind of analysis can be useful for market studies either globally or within individual countries.

Purchasing power parity income quintile and chicken/egg per capita consumption in kg

Quintile	Yearly Income	Chicken	Egg	Total
1	\$26,000	22	18	40
2	\$7,000	15	14	29
3	\$4,000	9	9	18
4	\$2,000	3	6	9
5	\$1,000	1	3	4
Average	\$8,000	10	10	20

Key Words: Income Quintile, Egg Consumption, Chicken Consumption

873 Withdrawn by author. , .

Animal Behavior & Well Being III

874 Choice of attractive conditions by beef cattle in a Y-maze just after release from restraint. T. Ishiwata*¹, R. J. Kilgour², K. Uetake¹, Y. Eguchi¹, and T. Tanaka¹, ¹*School of Veterinary Medicine, Azabu University, Sagami-hara, Japan,* ²*Agricultural Research Centre, NSW Agriculture Trangie, NSW, Australia.*

To determine the attractiveness of different conditions to cattle, 189 Angus heifers were individually allowed to enter a choice area after 2 min of restraint in a crush to choose between 2 pens. After the animal had chosen a pen, she could freely access both test pens and the choice area for 5 min. In experiment 1, each heifer was given one of the following choices: pen with 3 familiar animals (Peers) vs. pen with a pile of hay on a metal rack (Food) (n=34); Peers vs. the bare pen (Bare) (n=34); Food vs. Bare (n=35). More heifers chose Peers over Bare ($\chi^2=5.76$; $P<0.05$). More heifers tended to choose Peers over Food ($\chi^2=2.94$; $P<0.10$), whereas Food and Bare did not differ. The latency to choose either pen was shorter ($P<0.01$), and they spent less time staying near the crush ($P<0.05$) if Peers was one of the two choices. After choosing, more heifers entered the Peers pen than the Food ($P<0.05$) and Bare ($P<0.01$) pen. Peers were the most attractive for heifers, and food was as least attractive as the bare condition was. In experiment 2, another 86 heifers were given one of the following choice: pen with a familiar handler standing inside (STI) vs. pen with a novel object (NO) (n=29); pen with the handler standing outside the pen (STO) vs. NO (n=29); pen in which the handler is sitting inside (SI) vs. NO (n=28). Fewer heifers chose the pen with the human ($\chi^2=9.97, 12.45$ and 7.00 for STI, STO and SI, respectively; all $P<0.01$). Except for the choice of STO vs. NO, the number of heifers that had voluntarily chosen either pen was larger than that of heifers that had not chosen 5 min after release (both $P<0.01$). The number of times in which the NO pen was entered was larger than the STI and STO (both $P<0.01$), although the numbers of times in which the SI and NO pens were entered was not different. Heifers avoided human, especially with them standing outside the fence. Heifers seem to recognize the sitting human as a kind of object.

Key Words: Beef Cattle, Behavior, Preference Test

875 Out-wintering pads (owp) for steers- animal wellbeing and production. M. C. Hickey*¹, A. P. Moloney², and P. French², ¹*Teagasc Beef Research Centre Grange, Dunsany, Co. Meath, Ireland,* ²*Teagasc Beef Research Centre, Dunsany, Co. Meath, Ireland.*

Indoor slatted floor accommodation raises fundamental concerns for animal wellbeing. The objectives of these 2 experiments were to evaluate the effect of accommodating steers, on OWP or indoors on slats a) with or without daily exercise, b) with access to an OWP or c) with modified slat surfaces, on animal wellbeing and production. In experiment 1, 54 steers were assigned to one of 3 treatments (i) slats at $3\text{m}^2/\text{hd}$, (ii) as with (i) but walked $4\text{km}/\text{d}$ or (iii) accommodated on an OWP. In experiment 2, 75 steers were assigned to one of 5 accommodation systems (i) slats at $2.5\text{m}^2/\text{hd}$, (ii) OWP at $18\text{m}^2/\text{hd}$, (iii) slats at $2.5\text{m}^2/\text{hd}$ with access to an OWP, (iv) rubber matted slats at $2.5\text{m}^2/\text{hd}$ or (v) straw bedding at $4\text{m}^2/\text{hd}$. Animals were offered grass silage ad-lib and 6kg grain daily in experiment 1 and a silage/grain mixture in experiment 2.

Diurnal lying and eating behavior, hoof health, cleanliness, feed intakes, liveweight and slaughter data was recorded. Both experiments were of 5-month duration after which all animals were slaughtered. There was no effect of treatment on the duration of time spent lying or eating on either study. In experiment 1 animals accommodated on slats were dirtier ($p<0.01$) than animals accommodated on OWP, and had a greater incidence of medial erosion ($p<0.05$) on the hind, and lateral and medial erosion on the front hoof. Animals on the OWP had higher ($p<0.05$) feed intake and carcass gain than animals on slats. The inclusion of daily exercise did not affect animal behavior, intake or carcass gain. In experiment 2, when given access to an OWP, animals chose to lie outside irrespective of weather conditions. Animals accommodated on slats were dirtier ($p<0.05$) and had lower carcass gain ($p<0.05$) and feed intake ($p<0.01$) than animals accommodated on or with access to OWP. The provision of straw bedding or rubber matted slat surfaces did not affect behavior, feed intake or carcass gain, relative to animals housed on slats. In conclusion, the performance and wellbeing of steers was enhanced when accommodated on OWP rather than slats with or without modified surfaces.

Key Words: Beef Production, Outwintering, Slatted Accommodation

876 Effect of feeding *Ascophyllum Nodosum* on thermoregulation, behavior, and dehydration of sheep subjected to 12-h of transport. G. S. Archer*, T. H. Friend, C. Iacono, P. Krawczel, and R. Johnson, *Texas A&M University, College Station, TX.*

In order to determine the effect of feeding the seaweed *A. Nodosum* on thermoregulation, behavior and dehydration, 44 lambs ($26\text{ kg} \pm 4.3$) were fed one of four levels of the seaweed for two wk prior to 12-h transport during hot weather. Sheep received seaweed at either 0, 0.5, 1.0, or 2.0% of dry matter intake per day. Each sheep swallowed four gelatin capsules twice a day filled with *A. Nodosum* or their normal ration, depending on the treatment. Prior to transport, temperature data loggers were secured in the ear of all sheep to measure changes in body temperature during transport. Blood samples were taken immediately before and after transport. When the 0% lambs body temperature peaked, the 2% lambs were significantly lower ($P = 0.03$), with the other treatments being intermediate. Variation in body temperature during the course of transport for the 0% lambs (1.3 C) was wider than the 2% lambs (0.9 C , $P = 0.055$). All sheep immediately went to feed post-transport. There was a trend ($P = 0.21$) for 2% lambs to have the shortest latency to drink (589 s) and for 0% lambs to have the longest (823 s). All sheep laid down at approximately the same time post-transport. The 0% lambs significantly increased in sodium (Na), chloride (Cl), and potassium (K) and the 0.5% lambs significantly increased in K concentrations post-transport compared to pre-transport concentrations. Changes in electrolyte concentrations for the other treatments were not different from pre-transport concentrations. Post-transport concentrations of Na and Cl were less ($P < 0.05$) in 1 and 2% lambs than in 0 and 0.5% lambs. The 0% lambs also had higher ($P < 0.05$) K concentrations post-transport than 1 and 2% lambs. Feeding *A. Nodosum* for two weeks prior to transport allowed the animals to better thermo regulate during

transport under hot conditions. Although animals who received higher amounts of A. Nodosum prior to transport tended to drink sooner after transport, they actually had lower electrolyte concentrations post transport, indicating they were better hydrated.

Key Words: Hydration, Thermoregulation, Transport

877 The effect of a naloxone implant on the oestrus behavior, the LH preovulatory surge and on the ovulation rate of the crossbred Mexican ewe during the breeding season. V. Fuentes* and P. Fuentes*, *Centro Universitario de los Altos, Universidad de Guadalajara, Tapatitlan, Jalisco, Mexico.*

With the objective of studying the effect of a naloxone implant on oestrus behavior in the ewe, two groups of 10 crossbred Mexican ewes were selected at random during the breeding season of 2002. One group was implanted with a pellet containing 10 mg of naloxone and the second group received an implant with no drug. The same day of implant all ewes were treated with intravaginal sponges impregnated with 40 mg Medroxi Progesterone Acetate, after 14 days, sponges were withdrawn and 2 ml blood samples were taken through a jugular catheter, at intervals of 20 minutes since 24 hours after the sponges were withdrawn, sampling continued until the beginning and until the end of oestrus. It was observed that in ewes treated with naloxone the Preovulatory LH surge was advanced in the order of 4 h as compared with controls ($p < 0.001$). Furthermore, the duration of oestrus in naloxone treated ewes was significantly longer from that of control ewes (40 ± 6 h vs 28 ± 3 , $p < 0.001$). Ovulation rate in treated animals was in the order of 2.3 ± 5 vs $1.5 \pm .4$ of control ewes ($p < 0.01$). It was concluded that naloxone treatment altered oestrus behavior and ovulation rate. Giving further support to endogenous opioids as modulators of sexual behavior in the ewe.

Key Words: Naloxone, Oestrus, LH

878 Utilization of an onboard watering system by slaughter horses during transport. C. M. Iacono*, T. H. Friend, R. Johnson, P. Krawczel, and G. Archer, *Texas A&M University, College Station.*

This study determined if slaughter horses would drink onboard a semi-trailer, how long water needed to be available, and if water consumption reduced weight loss. Data were from three shipments of slaughter horses originating from Amarillo, TX (16 h, $n=17$), Hutchinson, KS (23 h, $n=19$) and La Grande, OR (28 h, $n=14$). The 19.2 m long semi-trailer was divided into three compartments and ten video cameras were mounted in the trailer to quantify drinking behavior. Five to 10 horses of different breeds, ages, sexes and body condition were placed into each compartment. Horses in two compartments were given water (two 1-h watering sessions for the TX and KS trips, and three for OR) with the third non watered compartment serving as a control. Horses were weighed before and after transport. The mean temperatures inside the trailer for the trips were 30, 22 and 18° C for the TX, KS, and OR trips. For the TX trip, 88.2% of the horses drank at least once during the first watering session. All of the horses on the KS trip drank at least one time during the two watering sessions. For the OR trip, 85.7% of the horses drank at least once over the three watering sessions. For TX, the majority of horses drank within the first 20 min whereas for KS and OR, it was not until 50-60 min that the majority of horses drank. Horses that had access to water on the TX trip lost less weight ($P = 0.018$) than those that did not have access to water. During the cooler weather trips, a trend was evident for the watered horses in the KS ($P = 0.19$), but not OR ($P = 0.74$) trips, to lose less weight. Water consumption averaged 3.79 L/horse during TX, 1.85 L for KS, and 2.80 L for OR. The results from this study indicate slaughter horses will drink during transport if given the opportunity and are more likely to drink sooner when they are transported during hot weather. Watering during transport in hot weather will result in significantly less shrink.

Key Words: Horse, Transport, Drinking

879 Effect of continuous versus rested transport on blood chemistry, electrolytes and behavior of lambs. P. Krawczel* and T. Friend, *Department of Animal Science, Texas A&M University, College Station.*

A proposed set of European Union Regulations for the transportation of livestock requiring multiple rest periods was evaluated for its efficacy. Rambouillet crossbred lambs averaging 17.6 ± 0.5 kg were randomly assigned to one of three treatments: continuously transported for 22 h ($n = 15$); transported for 8 h, unloaded and rested for 6 h, transported for 8 h, unloaded and rested for 24 h, transported for 6 h ($n = 15$); or control which remained in the home pasture throughout the study ($n = 16$). Food and water were provided during rest, which was in novel pens to simulate actual transport. Jugular blood samples were collected from all sheep prior to transport, at the end of each transport or rest period and 24 h after the conclusion of transport. Feeding behavior during rest stops and after final unloading were also quantified. After 14 h, glucose ($P = 0.0001$) decreased while total serum protein ($P = 0.011$) and bilirubin ($P = 0.011$) increased for continuous relative to rested or control. At the conclusion of transport for continuous, glucose ($P = 0.0001$) and magnesium ($P = 0.005$) decreased while blood urea nitrogen ($P = 0.0001$), total serum protein ($P = 0.036$), bilirubin ($P = 0.0001$) and creatinine ($P = 0.01$) increased relative to rested or control. Electrolytes varied between all three treatments at 14 h and 22 h, but no distinct pattern was evident. Both transported treatments chose feed over water immediately following unloading. The latency between unloading and first bout of drinking for continuous (23.9 ± 1.4) and rested (17.7 ± 4.5) was not different. The food and water provided during rest periods prevented signs of food deprivation in the rested lambs, which occurred in the continuous lambs. Blood chemistry and behavioral data indicated access to food was the main benefit of the rest periods. Dehydration was not evident in the continuous lambs despite temperatures peaking at 41° C.

Key Words: Lamb, Transport, Behavior

880 The effect of long-chain polyunsaturated fatty acid and vitamin E supplementation of ewes on neonatal lamb vigour. J. L. Capper*, R. G. Wilkinson, S. E. Pattinson, A. M. Mackenzie, and L. A. Sinclair, *Harper Adams University College, Newport, Shropshire, United Kingdom.*

The long-chain polyunsaturated fatty acid (PUFA) docosahexaenoic acid (DHA) is vital for development of the foetal brain: studies in humans have shown positive effects of DHA supplementation upon infant cognitive development and visual acuity. As ruminant diets are low in DHA, a behavioural response to supplementation may be observed. Furthermore, supplementing pregnant ewes with high levels of vitamin E produces lambs that are more vigorous immediately after birth. This experiment investigated the effects of dietary long-chain PUFA and vitamin E supplementation of ewes on neonatal lamb vigour. Forty eight Lley and Mule ewes were allocated to one of four treatments at 103 days of gestation in a 2 x 2 factorial, randomised block design. Ewes were individually penned from six weeks *pre-partum* to four weeks *post partum* and fed one of four treatment concentrates, each containing either fish oil plus Incomega (a DHA source fed at a 25:75 ratio with fish oil) or Megalac as the main fat source and a basal (50mg/kg) or supra-nutritional (500mg/kg) concentration of vitamin E. At lambing, lambs were focal sampled and the latencies of standing and successful suckling were recorded. Birthweight data was recorded at +12 hours *post partum*. Gestation length was significantly increased in ewes fed fish/DHA (147.8 days v.s 145.6 days; s.e.d 0.51, $P < 0.001$) and lambs born to these ewes suckled on average, 9.4 minutes sooner than lambs from the Megalac treatment (34.0 minutes vs. 43.4 minutes; s.e.d 3.48, $P < 0.01$). Moreover, supra-nutritional vitamin E supplementation reduced the latency of standing in lambs from ewes fed fish/DHA (14.9 minutes vs. 23.6 minutes; s.e.d. 3.23, $P < 0.05$) when compared to those fed Megalac. Supplementation of pregnant ewes with supra-nutritional levels of vitamin E conferred a 0.31kg increase in lamb birthweight (4.17kg vs. 3.86kg; s.e.d 0.135, $P < 0.05$). Long-chain PUFA supplementation of ewes had beneficial effects on neonatal lamb vigour. Supra-nutritional vitamin E supplementation of ewes significantly increased lamb birthweight, however it did not directly affect lamb behaviour.

Key Words: Behaviour, Neonate, Fatty Acid

Breeding and Genetics: Beef Cattle

881 Estimates of genetic parameters for infectious keratoconjunctivitis in beef calves before weaning. G. D. Snoder*¹, L. D. Van Vleck², L. V. Cundiff¹, and G. L. Bennett¹, ¹USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE, ²USDA-ARS, U.S. Meat Animal Research Center, Lincoln, NE.

Bovine infectious keratoconjunctivitis (BIK, pinkeye) is an economically important illness affecting growth of calves. The primary objective of this study was to estimate genetic parameters for BIK in beef calves prior to weaning. Health records of 47,880 calves born at the Meat Animal Research Center, Clay Center, NE from 1983 through 2001 were evaluated. Cows and calves were monitored daily for health until weaning at approximately 194 d of age. Breed groups consisted of nine purebred breeds (Angus, Braunvieh, Charolais, Gelbvieh, Hereford, Limousin, Pinzgauer, Red Poll, and Simmental), and three composite breeds (MARC I, MARC II, and MARC III). Detection of BIK was by physical examination. If BIK was detected during the preweaning period a score of 100 was assigned and if not the score was 200. Overall average prevalence of BIK was 6.5%. Prevalence was significantly greater in Hereford (22.4%) compared to all other breeds. Pinzgauer and Braunvieh breeds had the lowest incidence rates of 1.3 and 1.8%, respectively. Infections began at approximately 45 d of age and frequency of infections increased until approximately 105 d of age. Variance components for each breed were estimated using REML. Fixed effects included year of birth, age of dam, sex of calf, and birth weight. Calf and dam of the calf (direct and maternal genetic) were random effects. Variance due to maternal permanent environmental effects was not significant. Heritability estimates for the direct effect of the calf ranged from 0.00 to 0.28. Hereford and Angus breeds had the highest heritability estimates, 0.28 and 0.25, respectively. Heritability estimates for the maternal effect were low and ranged from 0.00 to 0.11. Estimates of the direct-maternal genetic correlation were highly variable and ranged from -1.00 to 1.00. Within breed, response to selection to reduce the incidence of BIK in calves would be expected to be slow although breed differences suggest a potential to improve BIK resistance by selection, especially in the Hereford breed.

Key Words: Heritability, Disease, Maternal

882 Investigation of gestation length in *Bos indicus* x *Bos taurus* reciprocal backcross calves produced through embryo transfer. T. S. Amen*, A. D. Herring, C. A. Gill, and J. O. Sanders, Texas A&M University, College Station.

Gestation length (GL) was studied on 511 embryo transfer calves belonging to 28 full-sib families born 1990-1996. Calves were produced by backcross matings involving three distinct sire and dam types: Angus (A), *Bos indicus* (B) (Brahman), and F₁ Angus-*Bos indicus* (Brahman or Nellore). Resulting progeny were 3/4 A-1/4 B, or 3/4 B-1/4 A. Calves were born to recipients that were approximately 1/2 Brahman and 1/2 British. Data were studied through analysis of covariance with independent variables of sex, sire-type x dam-type interaction (ST x DT), family nested within ST x DT, sex x ST x DT, embryo quality (EQ), embryo stage (ES), and the regression on birth date within season-year combination. Family nested within ST x DT was considered a random effect, and was the error term to test for differences due to ST x DT. Calf sex, EQ, regression on birth date, and the ST x DT interaction accounted for variation ($P < .05$) in GL. The three-way interaction involving calf sex, ST and DT was not significant as is typically seen for birth weight in these reciprocal cross calves. Male calves averaged 291.2 d and female calves averaged 288.5 d. For A backcross calves, GL averaged 286.8 d from A x F₁ matings, but averaged 289.3 d from F₁ x A matings. For B backcross calves GL averaged 293.8 d from B x F₁ matings, but averaged 289.5 d from F₁ x B matings. Additionally, type of F₁ parent (AB or BA, sire breed first) was found to account for significant differences in GL. Among calves from A sires and F₁ dams, GL was 5 d longer in calves from BA dams (289.6) as compared to those from AB dams (284.5). Among calves from F₁ sires and A dams, GL was 2 d longer in calves from BA sires (290.8) than in calves from AB sires (288.4). For calves from B sires and F₁ dams, GL was 4 d longer in calves from BA dams (296.1) as compared to those from AB dams (292.4). For calves from F₁ sires and B dams, GL was 3 d longer in calves from BA sires (291.1) than calves from AB sires (288.3). In both

the A and B backcross calves the trend was to have a longer GL when the F₁ parent was BA as opposed to AB.

Key Words: Reciprocal Cross, Embryo Transfer, Gestation Length

883 Genetic correlations between postweaning feed efficiency and cow traits. P. F. Arthur*¹, J. A. Archer², A. Reverter³, D. J. Johnston⁴, and R. M. Herd⁵, ¹NSW Agriculture - Camden, Australia, ²AgResearch, Mosgiel, New Zealand, ³CSIRO, Brisbane, Australia, ⁴Animal Genetics and Breeding Unit, Armidale, Australia, ⁵NSW Agriculture - Armidale, Australia.

Postweaning records on 1781 bulls and heifers tested for feed efficiency at 267 d of age and cow records taken at 4 y of age on 751 of the same females were used to estimate genetic correlations between postweaning feed efficiency and cow traits. The study was conducted at NSW Agriculture Research Centre, Trangie. The postweaning feed efficiency traits used were residual feed intake (RFI) and feed conversion ratio (FCR). RFI was calculated as the difference between actual daily feed intake and that predicted from a model that included metabolic weight and ADG. FCR was calculated as daily feed intake per unit ADG. For both traits efficient animals will have lower values. The cow records were taken on non-pregnant cows after the weaning of their second calf. The cow traits were daily feed intake (COWFI), ultrasound measure of rump fat depth (COWFAT), longissimus muscle area (COWEMA) and weight at 4 y of age (4-yWT). Genetic parameters were estimated by REML using animal models. All analyses included pedigrees back to 3 generations of ancestors. Means for the traits were 0.04 kg, 7.56, 15.7 kg, 13.2 mm, 81.3 cm² and 498.3 kg, for RFI, FCR, COWFI, COWFAT, COWEMA and 4-yWT, respectively. Corresponding heritability estimates were 0.42, 0.28, 0.27, 0.47, 0.12 and 0.62. The genetic correlation between RFI and the cow traits were 0.74 (COWFI), 0.32 (COWFAT), 0.41 (COWEMA) and -0.03 (4-yWT). Corresponding values for FCR were 0.39 (COWFI), 0.32 (COWFAT), 0.12 (COWEMA) and -0.33 (4-yWT). The results indicate that when selection of young cattle for improved feed efficiency is based on FCR a weak correlated response in reduced cow feed intake and increased cow weight is expected. However, when selection of young cattle for improved feed efficiency is based on RFI a strong correlated response in reduced cow feed intake is expected with no response in cow weight.

Key Words: Cattle, Feed Efficiency, Body Composition

884 Investigation of birth weight in *Bos indicus* x *Bos taurus* reciprocal backcross calves produced through embryo transfer. T. S. Amen*, A. D. Herring, C. A. Gill, and J. O. Sanders, Texas A&M University, College Station.

Birth weight (BWT) was studied on 511 embryo transfer calves belonging to 28 full-sib families born 1990-1996. Calves were produced by backcross matings involving three distinct sire and dam types: Angus (A), *Bos indicus* (B) (Brahman), and F₁ Angus-*Bos indicus* (Brahman or Nellore). Resulting progeny were 3/4 A-1/4 B, or 3/4 B-1/4 A. All calves were born to recipient dams that were approximately 1/2 Brahman and 1/2 British. Data were studied through analysis of covariance that included independent variables of sex, sire-type x dam-type interaction (ST x DT), family nested within ST x DT, sex x ST x DT, embryo quality (EQ), embryo stage (ES), and the regression on birth date within season-year combination. Family nested with ST x DT was considered a random effect, and was the error term to test for differences due to ST x DT. Calf sex, the regression on birth date, ES, and the three-way interaction sex x ST x DT accounted for variation in BWT ($P < .05$). Male calves averaged 38.2 kg, and female calves averaged 35.2 kg. Among A backcrosses, A x F₁ calves were 3.5 kg lighter ($P = .04$) than F₁ x A calves (34.9 vs. 38.4). Also, among B backcrosses, F₁ x B calves were 4.7 kg lighter than B x F₁ calves (34.4 vs. 39.1). Among A backcross calves from A sires and F₁ dams, the BWT difference was 1.8 kg between male (35.5) and female (34.3) calves, but when A backcross calves were produced from F₁ sires and A dams the difference in male vs. female BWT was 5.0 kg (40.9 vs. 35.9 kg, respectively). For B backcross calves produced from B sires and F₁ dams, male calves averaged 4.6 kg heavier than females (41.4 vs. 36.8 kg), whereas when B backcross calves were produced from F₁ sires and B dams, BWT of male

calves (35.0 kg) averaged 1.2 kg heavier than female calves (33.8 kg). These *Bos indicus*-*Bos taurus* reciprocal differences have been widely reported in natural service calves, and these results are consistent with earlier reports in ET calves.

Key Words: Reciprocal Cross, Embryo Transfer, Birth Weight

885 Teat scores in first-parity Gelbvieh cows: Relationship with suspensory score and calf growth traits. R. L. Sapp*, R. Rekaya, and J. K. Bertrand, *The University of Georgia, Athens.*

Teat and suspensory scores from 9,418 first-parity Gelbvieh (GV) cows and growth records from 19,119 calves were used to estimate genetic and environmental parameters for teat and suspensory scores and to investigate the relationship of teat and suspensory scores with calf growth traits and maternal genetic growth effects. First-parity cows did not have multiple scores within 280 d, gave birth to one calf, were 4 yr of age or younger at first-calving, and were at least 50% GV. Producers scored cows within 24 h of parturition. Teat score (T), a subjective measure of teat size, ranged from 0 (very large) to 50 (very small) and suspensory score (S), a subjective score of udder support, ranged from 0 (very pendulous) to 50 (very tight). Unadjusted birth (BW), weaning and yearling weight of the calves, born in the first three parities to the first-parity cows, were used to calculate pre- (WG) and postweaning (YG) ADG. A mixed model was employed for the multiple trait analysis of T, S, BW, WG, and YG which included herd-yr, mo of calving, age of cow at calving and sex of calf (included only for BW, WG, and YG) as systematic effects; regression on percentage GV; and additive animal, maternal genetic and permanent environment of dam (included only for BW and WG), and residual as random effects. Heritability estimates were 0.27, 0.22, 0.39 (0.09), 0.27 (0.14) and 0.21 for T, S, direct (maternal) BW, (maternal) WG and YG, respectively. The genetic correlation between T and S was 0.95. The genetic correlations between T (S) with direct BW, WG and YG and with maternal BW ranged from -0.18 to 0.38. The genetic correlation between T (S) with maternal WG was -0.47 (-0.55) suggesting that cows with smaller teats and tighter udders produced less milk. Pearson correlations between EBV of T and S with maternal WG indicate that animals with extremely large or small EBV for T or S may have problems with accessibility of milk or adequate milk production. Therefore, it may be more beneficial for producers to select animals with intermediate EBV for T and S.

Key Words: Growth, Suspensory Score, Teat Score

886 Calving day and age at first calving in Angus heifers. J. Minick* and D. Wilson, *Iowa State University, Ames.*

Reproduction is one of most economically important traits in beef production. Due to difficulties in data collection and analysis, in most breeds there has been no objective way to evaluate fertility in females on a between-herd basis. The objective of this study was to determine if calving date (CD) and age at first calving (AFC) could be used to select for female fertility in beef cattle. Records ($n = 2082$) from a university research herd and a large purebred breeder were used. There were a total 147 sires with heifers represented in the CD data. CD was calculated for each heifer by subtracting the calving date of the first heifer to calve in that contemporary group from the calving date of the heifer. For example, within each contemporary group of heifers, heifers that calved on the first day of the calving season were given a calving day of one. Heifers that calved the next day had calving days of two, and so on. To avoid bias, non-calving heifers were assigned a CD of 30, 60, and 90 days after the last heifer in that contemporary group calved. These assigned CD were also used to give open heifers a predicted AFC. Data were analyzed by MTDFREML using a general linear animal model. Fixed effects included herd-year, service sire of the heifer, and age of dam. Covariates that were tested included adjusted yearling weight and age of the heifer at the start of the breeding season (for CD only). Heritabilities for CD for the 30, 60, and 90 day adjustments were 0.07 ± 0.04 , 0.10 ± 0.05 , and 0.11 ± 0.05 , respectively. Average, minimum, and maximum estimated breeding values for sires of heifers were 0.7, -10.6, and 9.8 days for CD30; -1.1, -17.2, and 16.5 days for CD60; and 1.6, -22.6, and 19.5 days for CD90. The estimates for AFC30, AFC60, and AFC90 were 0.28 ± 0.06 , 0.28 ± 0.06 , and 0.28 ± 0.06 , respectively.

Average, minimum, and maximum estimated breeding values for sires of heifers were 0.6, -46.6, and 45.9 days for AFC30; -1.2, -50.1, and 51.6 days for AFC60; and 1.7, -52.9, and 56.7 days for AFC90. These results indicate that AFC may be more useful than CD in selecting for female fertility in beef cattle.

Key Words: Fertility, Calving Day, Age at First Calving

887 Genetic prediction for estimating mature cow maintenance energy requirements. S. E. Speidel*, D. J. Garrick, and R. M. Enns, *Colorado State University, Fort Collins.*

Cow maintenance energy requirements are defined as the amount of dietary metabolizable energy required for maintenance. According to NRC (1996) nutrient requirements of beef cattle, maintenance requirements account for roughly 70% of the total metabolizable energy requirements of a beef cow. The goal of this project was to develop a selection tool to assist producers in improving beef production efficiency by simultaneously accounting for change in income (sale weight) and cost (cow maintenance). A genetic prediction for mature cow maintenance energy requirements was developed using equations from the 1996 NRC to predict the energy required for maintenance of a beef cow and Woods lactation function. These equations were modified so an animals genetic prediction for metabolic weight and weaning weight maternal could be used to predict its maintenance energy requirements through a non-linear combination of the two traits. Metabolic weight genetic predictions were calculated by random regression using Best Linear Unbiased Prediction (BLUP) procedures where metabolic weight (mature cow weight pre-adjusted to condition score 5 and raised to the power 0.75) was regressed on age to predict metabolic weight at 5 years of age. Weaning weight maternal genetic predictions were estimated by applying BLUP procedures to an animal model with birth weight and weaning weight as the dependent variables. A prediction error variance equation was developed using the algebra of variances and co-variances in concert with the genetic prediction equation. The prediction which is reported as a progeny difference in the units of mega-calories per month has been adopted by the Red Angus Association of America and will be published in their 2004 sire summary.

Key Words: Genetic Prediction, Cow Efficiency, Maintenance

888 Estimates of genetic correlations among carcass traits adjusted to different end points. A. Rios-Utrera*¹, L. V. Cundiff², K. E. Gregory², R. M. Koch¹, M. E. Dikeman³, M. Koohmariaie², and L. D. Van Vleck⁴, ¹University of Nebraska, Lincoln, ²Roman L. Hruska U.S. Meat Animal Research Center, ARS, USDA, Clay Center, NE, ³Department of Animal Sciences and Industry, Kansas State University, Manhattan, ⁴Roman L. Hruska U.S. Meat Animal Research Center, ARS, USDA, Lincoln, NE.

Carcass measurements of 1,664 serially slaughtered steers from 12 breeds (Red Poll, Hereford, Angus, Limousin, Braunvieh, Pinzgauer, Gelbvieh, Simmental, Charolais, MARC I, MARC II, and MARC III) were used to estimate genetic correlations among carcass traits adjusted to slaughter age, carcass weight or backfat thickness end points. Traits were carcass weight (CW), dressing % (DP), fat thickness (FT), longissimus area (LA), kidney pelvic heart fat % (KF), marbling (MS), yield grade (YG), predicted % of retail product (ER), retail product wt (RW), fat wt (FW), bone wt (BW), retail product % (RP), fat % (FP), and bone % (BP). The model included breed group, feed energy level, age of dam, year of birth, significant interactions, number of days on feed, and end point nested within breed (except age) as fixed effects, and genetic effect of animal and total maternal effect of dam as random effects. Genetic correlations, estimated by REML, for CW LA, FT RW, LA-KF, LA YG, LA ER, LA FW, LA-BW, LA RP, LA FP, KF RW, KF BW, ER RW and ER RP at constant age, wt, or fat thickness, respectively, were .32, -, and .51; .26, .77, and ; -.01, -.10, and .25; .71, .89, and .66; .68, .85, and .63; .16, -.51, and .22; .24, -.19, and .30; .47, .57, and .27; .44, -.43, and .18; .02, .48, and .15; .08, .55, and .04; .26, .80, and .01; and .72, .73, and .32. The magnitude and the sign of the genetic correlation changed across end points for many pairs of traits. Correlated responses to selection would differ depending on end point. Regardless of end point, FT was highly correlated with YG (.86, .85; common age and wt) and ER (.85, .82; common age and wt), indicating that selection for reduced

FT would improve YG and ER. Carcass quality, however, would be affected negatively because of the moderate genetic correlations (.34, .35; common age and wt) between MS and FT.

Key Words: Carcass Traits, Genetic Correlations, Slaughter End Points

889 Genetic evaluation of beef cattle for growth using records across a wide range of ages. J. Bohmanova* and I. Misztal, *University of Georgia, Athens.*

A simulation study was conducted to validate agreement between multitrait model (MT) and random regression model (RRM) estimates of growth in beef cattle. Secondary goal was to compare RRM with Legendre polynomials and RRM with splines. Four data sets were generated assuming RRM with cubic regression on Legendre polynomials of age for direct genetic and permanent environmental, maternal genetic and maternal permanent environmental effect. First data set contained records located exactly at 1, 205 and 365 days of age. Second data set consisted of records at 1, 205 ± 45 and 365 ± 45 days. Third data set was created by adding two extra records at 100 and 300 days to the first data set. Fourth data set contained birth weight and records located in an interval of 45 days around 100, 205, 300 and 365 days. Three models were fitted: 1) multitrait model with preadjustment to constant age and traits defined at 1, 205 and 365 days of age; 2) random regression model with Legendre polynomials; and 3) random regression model with linear splines. Variance components in all models were equivalent at 1, 205 and 365 days. Accuracies were calculated as correlation between simulated and predicted breeding values estimated at 1, 205 and 365 days of age. Multitrait and both random regression models showed excellent agreement in the first data set. RRM were 1.4 %, 1.9 %, 2.0 % more accurate than MT at 1, 205 and 365 days of age, respectively, in the second data set. Accuracy of RRM with the third data set was 0.5 %, 2.5 %, and 0.2 % higher at 1, 205 and 365 days of age, respectively, over the first data set. Accuracy of RRM with the fourth data set was 0.5 %, 1.6 %, and 0.0 % higher at 1, 205 and 365 days of age, respectively, over the second data set. The gains in accuracy were small due to high genetic correlations between records. RRM with Legendre polynomials and RRM with linear splines gave almost identical results, however the model with splines converged six times faster. Random regression models were slightly more accurate than multitrait model. RRM with linear splines were simpler than such models with Legendre polynomials.

Key Words: Beef Cattle, Growth, Random Regression Model

890 Examining the genetic diversity of Hereford cattle. M. A. Cleveland*¹, R. M. Enns¹, D. J. Garrick¹, and H. D. Blackburn², ¹Colorado State University, Fort Collins, ²National Animal Germplasm Program, National Center for Genetic Resources Preservation, ARS, USDA, Fort Collins, CO.

This study characterized genetic diversity in the U.S. Hereford population by examining the level and rate of inbreeding and effective population size. The impact of breeding structure on inbreeding was evaluated. Pedigree records for 20,624,418 animals were obtained from the American Hereford Association. Inbreeding coefficients for 1900 to 2001 born animals and the mean annual inbreeding coefficients (Fm) were computed from the pedigree. The rate of inbreeding and effective population size were calculated for a subset of the pedigree using all animals born from 1900 to 2001. Inbreeding increased in a linear fashion reaching a maximum Fm of 0.115 in 1966. The rate of inbreeding was not constant over time and five periods were identified in which inbreeding was changing at different linear rates, including a decrease after 1966. Almost 95% of 2001 born individuals were inbred, and the maximum inbreeding coefficient was 0.759. For animals born between 1990 and 2001 inbreeding was less than 0.10 for 56% of the population and ranged from 0.10 to 0.199 for 34% of the population. The mean rate of inbreeding from 1990 to 2001 was estimated as 0.12%, equating to an effective population size of 85 animals. Influential sires and their contribution to the population were identified to help explain changes in the inbreeding trend. A potential explanation for the decrease in inbreeding levels from 1967 to 1986 may be a shift in the popularity of within breed lines leading to a decrease in coancestry among influential sires and selected dams. The fluctuation of inbreeding suggests that changing breeding objectives impacted sire selection, but further study of selection decisions

contributing to inbreeding in successive generations is needed. Most of the population is inbred suggesting that inbreeding levels should be factored into future mating programs to minimize the effects of inbreeding depression and the loss of genetic diversity.

Key Words: Hereford Cattle, Inbreeding, Genetic Diversity

891 Evaluation of Angus field records: Using new sets of variances to estimate weaning weight EPDs and the effect on genetic trends. A. Hassen* and D. E. Wilson, *Iowa State University, Ames.*

The objective of the current study was to evaluate the effect of using new sets of variance components on genetic trends and animal ranking for weaning weight (WWT) records. National Genetic Evaluation Programs for the Angus breed use heritability of 0.20 and 0.14 for weaning direct (WD) and weaning maternal (WM) effects, respectively. Current programs also assume zero covariances between WD and WM effects. In the present study, random samples of WWT records were used to estimate new sets of variance components. For each of the samples, covariances between WD and WM effects were negative and different from zero ($P < .01$). Means of variance estimates from the different samples were then used to calculate expected progeny differences. Weaning weight measures were analyzed together with postweaning gain (PWG) information using multiple trait animal model that included fixed effect of contemporary group (CG), random effects of direct genetic, maternal genetic, permanent environment, and an error term. Model for PWG included fixed effect of CG, random effects of direct genetic and residual. Mean trend for WD and WM effects based on currently used variances were 0.67 and 0.37 kg/yr, respectively. The corresponding values based on the new variance estimates were 0.72 and 0.28 kg/yr, respectively. Overall rank correlation between each of the new and currently published direct and maternal EPDs were 0.99 and 0.94, respectively. However, rank correlations were associated with the accuracy of EPDs. The relatively weaker rank correlations for groups of animals with low accuracy values may suggest that the use of negative covariances between WD and WM effects in cattle evaluation programs may influence the selection of young sires.

Key Words: Beef Cattle, Weaning Weight, Genetic Trend

892 Genetic evaluation of feedlot performance and efficiency in beef cattle marketed at a constant finish endpoint. C. J. B. Devitt*¹, J. W. Wilton², T. L. Fernandes², and S. P. Miller², ¹Beef Improvement Ontario, Guelph, ON, Canada, ²University of Guelph, Guelph, ON, Canada.

Objectives were to estimate genetic parameters and calculate genetic evaluations in the form of across breed comparisons (ABC, across breed EPD) for post-weaning feedlot performance traits in crossbred beef steers. Feedlot feed intake, feed:gain ratio, and growth data from 941 crossbred steers fed at the University of Guelph's Elora Beef Research Centre from 1996 to 2002 were analyzed. Steers were fed either a high-energy diet from start to finish or a haylage-based diet for the first 112 days and then a high-energy diet to finish. All animals were targeted to a slaughter criterion of 8 mm backfat, as determined by ultrasound measurements taken every 28 days. Seventy sires were represented from 5 different breeds (Angus, Simmental, Charolais, Hereford, Limousin), averaging 13 progeny per sire, ranging from 2 to 38. Three feedlot traits, average daily gain, final live body weight, and days on feed were available on all 941 animals. Two additional traits, daily dry matter feed intake, and feed:gain ratio were available on 452 of the steers. A multiple trait animal model was used to estimate genetic parameters and calculate ABCs for all five traits simultaneously. Model effects included regression on breed proportion, age at feedlot entry as a covariate, fixed effects of contemporary group (herd of origin, year, nutritional treatment), and the random animal effect. Heritability estimates were 0.32, 0.44, 0.15, 0.56, and 0.48 for average daily gain, average daily dry matter feed intake, average feed:gain ratio, final live body weight, and days on feed, respectively. Genetic correlation estimates of days on feed with final live weight and feed:gain ratio were 0.72 and 0.56, respectively. Across breed comparisons were calculated from the individual animal effect and the breed covariate solutions. Results show that selection has potential to improve feedlot efficiency in terms of optimizing performance to reach a desired size at a constant level of fatness. Multiple trait selection for

feedlot traits based on economic considerations of the production system is important to achieving improved feedlot performance to constant finish.

Key Words: Feed Efficiency, Beef Cattle, Heritability

893 Predicting breeding values for feed intake from individual or pen-fed data. K. M. Olson*, D. J. Garrick, and R. M. Enns, *Colorado State University, Fort Collins.*

The objective of this study was to determine the reduction in accuracy of breeding values when pen-fed rather than individual observations on feed intake (FI) were used. The simulated data set consisted of 1,000 animals with true breeding values (BV) and phenotypes for FI (heritability of 0.34) representing 49 sires and 200 maternal grandsires (MGS). Three approaches were compared to predict breeding values for FI (EBV). The first approach was animal model BLUP (IAM) using 1,000 individual FI records. The second approach used 500, 250 or 100 combined FI observations on pens of $i=2, 4$ or 10 animals (PAM_{*i*}). The residual variance was modified to account for the number of animals contributing to each pen FI observation. The third approach (IPM_{*i*}) allocated each animal in the pen the average of the pen FI and incorrectly treated that as a unique FI observation in animal BLUP. Correlations were determined between the BV and EBV for each approach, separately for animals with data, sires and MGS. Correlations were 0.633 for animals, 0.767 for sires and 0.266 for MGS using IAM. These correlations are consistent with expectations based on the heritability and amount of information available. Correlations for animals reduced to 0.532 (PAM₂), 0.470 (PAM₄) and 0.371 (PAM₁₀). Corresponding reductions were 0.774, 0.744, 0.619 for sires and 0.225, 0.107, 0.003 for MGS. When penned animals were treated as if they had individual FI the correlations were 0.531 (IPM₂), 0.465 (IPM₄), 0.365 (IPM₁₀) for the animals, 0.776, 0.742, 0.624 for sires, and 0.218, 0.097, 0.002 for MGS. The reduction in accuracy with penning is consistent with the reduction in available data. The correlations were almost identical whether BLUP was correctly accounting for penning (PAM_{*i*}) or allocating pen averages to each individual (IPM_{*i*}). The apparent accuracy computed from the coefficient matrix was overstated in IPM_{*i*}. Pen data can be effectively used in BLUP analyses when individual FI is not available. Correct account of pen information is recommended for reporting accuracy of EBV.

Key Words: BLUP, Accuracy, Animal Model

Breeding and Genetics: Swine

895 Validation of QTL's in a swine population selected for ovulation rate. M. R. Mousel*, G. A. Rohrer, K. A. Leymaster, and R. K. Christenson, *U.S. Meat Animal Research Center, USDA-ARS, Clay Center, NE.*

Variations in allele frequency of a four-breed, white composite population of swine selected for ovulation rate (OR) were evaluated. Animals were selected for 11 generations for increased OR and compared to unselected controls (CO). The selection line had an increase of 3.0 corpora lutea and an increase of 0.3 pigs in total litter size as compared to controls. DNA was collected from 146 CO and 156 OR gilts and boars at generations 10 and 11. A QTL analysis for OR identified loci on chromosomes 3, 8, and 10 in a Meishan-White composite population. Three microsatellite markers were selected for chromosomes 3 (17-42 cM) and 10 (85-96 cM) and six for chromosome 8 (1-13 cM) for utilization with selected and control lines. Allele frequencies of markers contained within QTL peaks were analyzed by logistic regression to ascertain any difference in allele frequency due to selection. All markers on chromosome 3 had significant ($P<0.01$) changes between lines in allele frequency. Odds ratio of the most significant marker ($P<0.0001$), SW2429 contained 7 distinct alleles, the 125 base allele was 530.2 times more likely to be present in homozygous OR animals than CO. Chromosome 8 had 3 of 6 markers with significant ($P<0.02$) changes in allele frequency. The marker SW2651, which contained 3 alleles, was most significant ($P<0.0001$) with an odds ratio of 2.6 for the 100 base allele in homozygous OR animals. Significant ($P<0.01$) changes in allele frequency were found on chromosome 10 with all markers. An odds ratio of 7.3 was calculated for the 107 base allele in homozygous OR animals for the most significant ($P<0.0001$) marker SWR1829 which had 8 alleles. Selection for OR has changed the allele frequency of markers from the three QTL regions studied. The QTL discovered in a Meishan cross

894 The use of ultrasound to evaluate growth and carcass quality in Nelore cattle. F. R. C. Araujo^{1,2}, F. Manicardi³, J. R. Hofig Ramos⁴, C. U. Magnabosco^{5,1}, T. R. Famula¹, and R. D. Sainz^{*1}, ¹*University of California, Davis*, ²*Aval Servicos Tecnológicos S/S, Uberaba, MG, Brasil*, ³*Grupo OMB, Pontes e Lacerda, MT, Brasil*, ⁴*Grupo HoRa, Cornélio Procópio, PR, Brasil*, ⁵*Embrapa Cerrados, Bolsista CNPq Brasília, DF, Brasil.*

This study was carried out to support the development of expected progeny differences (EPD) for carcass traits in Nelore cattle raised under tropical grazing systems. Data from 1,721 bulls and heifers raised in central Brazil (Grupo OMB and Grupo HoRa) were collected at approximately 15, 18, 21 and 24 months of age. The animals were weighed (BW) and scanned for longissimus muscle area (ULMA); backfat thickness between the 12th and 13th ribs (UFAT); and fat thickness over the rump (URFAT), at the P8 site. Mean (and SD) scan data were: Age, 19 (SD = 2.6) months; BW, 321 (SD = 58) kg; ULMA, 47.80 (SD = 8.85) cm²; UFAT, 1.5 (SD = 0.62) mm; URFAT 2.0 (SD = 0.97) mm. Data were analyzed using a mixed model. Fixed effects were age in months (AGE_m), month of scanning (MONTH), contemporary group (including management group; CGxMG). The interaction between AGE_m and MONTHSCAN was used to test the slopes for homogeneity, and the individual animal within contemporary and management group was included to account for repeated measures on the same animal. A large portion of observed variance in response variables was accounted for by GCxMG and AGE_m ($P < 0.001$). Month of scanning (i.e., season) had no effect on BW or ULMA ($P > 0.05$) when the contemporary and management groups were properly accounted for. UFAT was not significantly influenced by MONTH or by AGE_m ($P > 0.05$), nor was there any significant AGE_m x MONTH interaction. By contrast, URFAT was significantly affected by AGE_m ($P < 0.01$), indicating that it is a more sensitive fat deposit. The repeatabilities of measurements were very low for UFAT (0.035) but high for URFAT (0.62) and moderate for ULMA (0.44). Nelore cattle raised on tropical pastures exhibit growth patterns and carcass compositions that are very different from those observed in *Bos taurus* cattle raised on high-concentrate diets, but once the contemporary group and management were accounted for, seasonality had no effect on carcass traits and body weight.

Key Words: Beef Cattle, Carcass, Ultrasound

population are likely segregating in occidental germplasm. The selection line will be useful to identify causative genes and genetic markers for use in the industry.

Key Words: Swine, Ovulation Rate, Allele Frequency

896 Identification of quantitative trait loci affecting reproduction and early growth in pigs. J. Holl^{*1}, J. P. Cassady², D. Pomp¹, and R. K. Johnson¹, ¹*University of Nebraska, Lincoln*, ²*North Carolina State University, Raleigh.*

Quantitative trait loci (QTL) in a 3-generation population of a cross of low-indexing pigs of a randomly selected control line with high-indexing pigs of a line selected 10 generations for increased index of ovulation rate and embryonic survival were investigated. Birth weight (BWT, $n = 428$), weaning weight (WWT, $n = 405$), age at puberty (AP, $n = 295$), ovulation rate (OR, $n = 423$), number of fully formed pigs (FF, $n = 370$), number of pigs born alive (NBA, $n = 370$), number of mummified pigs (MUM, $n = 370$), and number of stillborn pigs (NSB, $n = 370$) were collected in F₂ females. Grandparent, F₁, and F₂ animals were genotyped for 151 microsatellite markers. Previous analyses with single Mendelian QTL models identified 16 putative QTL ($P < 0.10$). Data were reanalyzed with composite interval mapping (CIM) including models incorporating genomic imprinting. More QTL for reproductive traits than in the earlier scan (31 vs 16, $P < 0.10$) and two QTL for birth weight were identified. Mendelian QTL affected **FF** (C11, 52 cM, $P < 0.05$), **NBA** (C11, 71 cM, $P < 0.05$), **NSB** (C13, 100 cM, $P < 0.05$; C5, 131 cM, $P < 0.10$; C12, 37 cM, $P < 0.10$), **NN** (C11, 47 cM, $P < 0.05$; C8, 20 cM, $P < 0.05$; C7, 62 cM, $P < 0.05$), **AP** (C8, 172 cM, $P < 0.05$; C7, 1 cM, $P < 0.05$; C7, 58 cM, $P < 0.10$; C18, 40 cM,

P < 0.10; C8, 101 cM, P < 0.10; C8, 136 cM, P < 0.10; C12, 56 cM, P < 0.10), **MUM** (C12, 98 cM, P < 0.10; C12, 70 cM, P < 0.05; C2, 6 cM, P < 0.10; C6, 64 cM, P < 0.10; C6, 165 cM, P < 0.10), and **BWT** (C12, 17 cM, P < 0.10). Partially imprinted QTL affected **OR** (C9, 1 cM, P < 0.01), **BWT** (C6, 155 cM, P < 0.05), and **MUM** (C6, 81 cM, P < 0.05). Paternally imprinted QTL affected **NN** (C6, 85 cM, P < 0.05; C6, 171 cM, P < 0.10; C15, 64 cM, P < 0.10; C15, 109 cM, P < 0.10), **AP** (C15, 98 cM, P < 0.05), and **MUM** (C6, 191 cM, P < 0.10). Maternally imprinted QTL affected **NSB** (C14, 104 cM, P < 0.10), **NN** (C1, 155 cM, P < 0.10), and **MUM** (C2, 29 cM, P < 0.10). Power to detect QTL with small effects increases with CIM with imprinting compared to single QTL models.

Key Words: Pigs, Imprinting, Quantitative Trait Loci

897 Mapping genes affecting scrotal hernia condition in domestic pigs. F.-X. Du*, N. Mathialagan, C. J. Dyer, M. D. Grosz, L. A. Messer, A. C. Clutter, T. Wang, M. M. Lohuis, and J. C. Byatt, *Animal AG Monsanto Company*.

Scrotal hernia (SH) is a congenital defect that results from protrusion of part of the intestine through the abdominal opening of the inguinal canal and into the scrotum. The SH condition is affected by both genetic and environmental factors; however, the effect of ill-defined environmental factors and plausible involvement of multiple genes with likely incomplete penetrance complicate attempts to identify genetic determinants. To map SH genes, a whole genome scan (using microsatellite markers) was performed using 7 independent SH-affected paternal families from 3 commercial pig lines. An identity-by-descent based nonparametric linkage analysis of this dataset identified 3 chromosomes with suggestive statistical evidence for segregation of SH genes. Twenty-seven additional paternal SH families with 2 SH piglets were genotyped for 33 microsatellite markers on these 3 chromosomes, and the subsequent linkage analysis provided additional suggestive statistical evidence for 2 chromosomes: SSC2 and SSC12. Subsequently, an approximately 50 cM chromosomal region on SSC2 and a number of candidate genes from SSC2 and SSC12 were selected. Sequencing a panel of 24 animals identified multiple polymorphic single nucleotide polymorphisms (SNP) in both candidate genes and anonymous sequences derived from bacterial artificial chromosomes mapping to the targeted SSC2 region. Ultimately, 137 polymorphic SNP assays (107 on SSC2 and 30 on SSC12) were validated. Approximately 2,000 animals (sires, affected or unaffected offspring) of 143 paternal families (with at least 1 affected progeny or at least 80 progeny all absent of SH) from Pietrain sires were genotyped for all 137 SNP markers. Linkage disequilibrium analyses of this dataset provided additional statistical evidence for segregation of genes affecting SH on both SSC2 and SSC12, and helps to refine the map of SH genes and to identify associated candidate genes.

Key Words: Scrotal Hernia, Nonparametric Linkage Analysis, Linkage Disequilibrium Mapping

898 Prospecting for pig SNPs in the human genome: have we struck gold? L. Grapes*¹, S. Rudd², R. Fernando¹, K. Megy³, D. Rocha³, and M. Rothschild¹, ¹*Iowa State University, Ames*, ²*Institute for Bioinformatics, GSF-National Research Center for Environment and Health*, ³*University of Cambridge, Cambridge, UK*.

With increasing interest in performing genome-wide association studies in livestock, rapid identification of genetic markers is becoming a necessity. Single nucleotide polymorphism (SNP) discovery in pigs could be increased using in silico methods. In addition, if closely related species have similar SNP frequencies in their coding regions, SNP discovery in pigs could be increased by screening pig coding regions that are homologous to SNP-dense human coding regions. To test this hypothesis, we identified pig SNPs in silico. All porcine expressed sequence tags (ESTs) were downloaded from EMBL (www1.embl-heidelberg.de) and clustered. Clusters containing 8 or more ESTs were analyzed using the SNIpper algorithm, which assigns a score to a deviation within an EST relative to the consensus sequence. Of the clusters containing 8 or more ESTs, 452 contained at least one putative, high-scoring SNP, totaling 1,394 SNP loci. From these SNPs, 231 were located to the coding regions of 80 porcine genes or hypothetical proteins. Using pig coding SNPs (cSNPs) from 25 of these genes and validated human cSNPs from dbSNP (www.ncbi.nlm.nih.gov/SNP) in homologous genes, the correlation between the gene-specific frequency of human and pig cSNPs was

high (0.77; P < 0.00001) given stringent parameters used to identify pig SNPs in silico. This human-pig correlation represents a lower bound of the true correlation due to false-positive and false-negative results known to occur with in silico SNP detection methods. Using validated mouse and human cSNPs from dbSNP in 50 homologous genes, the correlation between the gene-specific frequency of human and mouse cSNPs was only moderate (0.48; P < 0.0005). These results follow the expectation that closely related species have similar mutation frequencies within their coding regions, which could be attributed to their high level of sequence identity. From 15 porcine in silico SNPs, 9 (60%) have been experimentally validated, indicating that EST-based in silico methods will increase the rate of SNP discovery in pigs. Also, the high human-pig correlation indicates that comparative methods can be used to capitalize on the large supply of human SNP information for rapidly identifying cSNPs in pigs.

Key Words: SNP, Pigs, Bioinformatics

899 An evaluation of performance and carcass characteristics between pigs sired by boars from two different time periods. C. R. Schwab*, T. J. Baas, D. W. Newcom, and K. J. Stalder, *Iowa State University, Ames*.

This study was conducted to evaluate differences in performance and carcass traits between pigs sired by boars currently available and pigs sired by boars from the mid 1980's. Two lines were developed by splitting and randomly allocating littermate and $\frac{1}{2}$ sib pairs of females for mating to current (CTP) or old (OTP) time period boars. Matings by CTP boars were made using fresh semen and matings by OTP boars were made using frozen semen. Subsequent boar, barrow, and gilt progeny from two replications were weighed on test at a mean pen weight of 39.8 kg. Off test ultrasonic measurements of 10th rib loin muscle area (LMA), backfat (BF10), and intramuscular fat percentage (IMF) were collected on a total of 789 pigs at a mean pen live weight of 109 kg. Records on pigs sired by CTP boars (n=556) were from 23 sires while pigs sired by OTP boars (n=231) were from 15 sire groups. All available barrows and randomly selected gilts (n=277) were then sent to a commercial abattoir and measurements of tenth-rib backfat (CBF10), last rib backfat (CLRBF), last lumbar backfat (CLLBF), and loin muscle area (CLMA) were collected. Time period differences were assessed by the use of a mixed model that included fixed effects of sire time period, replication, sex, contemporary group, and the interaction of sex by time period. Sire and dam nested within time period were included as random effects. There was no difference in average daily gain or adjusted days to 113.5 kg between the two time periods; however, pigs sired by CTP boars had significantly greater lean gain per day on test. Pigs sired by CTP boars had larger (P<0.05) LMA measurements and less BF10, while pigs sired by OTP boars had significantly more IMF. Carcass evaluation revealed more CLMA, and significantly less CBF10, CLRBF, and CLLBF for pigs sired by CTP boars when compared to pigs sired by OTP boars.

Key Words: Swine, Performance, Carcass

900 Characterization of a line of pigs selected for increased litter size for two RFLPs identified in *follicle-stimulating hormone receptor 1*. C. D. Blowe*, E. J. Eisen, O. W. Robison, and J. P. Cassady, *North Carolina State University, Raleigh*.

The objective of this study was to characterize changes in allelic frequencies for two RFLPs associated with the *follicle-stimulating hormone receptor 1* gene in a line of pigs selected for increased litter size (LS). The LS line was selected for increased number of fully formed pigs, and litters were standardized at birth so replacement gilts were reared in litters of ten or fewer pigs. A contemporary control line (C) was maintained. In generation nine, estimated mean breeding values for litter size differed between lines by 0.63 pigs (P < 0.01). *Follicle-stimulating hormone receptor 1*, a cysteine-rich glycoprotein encoded by a single gene, was investigated. Based on expression patterns and implications from studies involving *follicle-stimulating hormone receptor 1* function, it can be concluded that *follicle-stimulating hormone receptor 1* may play an important role in determining litter size. Intronic regions were amplified using PCR, and two different RFLPs, characterized by *MspI* (*FS1*) and *Fnu4HI* (*FS2*), were identified. Frequencies of the B allele of *FS1* increased in LS, and allele frequencies differed between LS and C by 0.25 and 0.18 in generations 10 and 11, respectively. The change in allele frequency for *FS1* differed from 0 in generations 10 (P < 0.01) and 11 (P < 0.057). Standard errors were adjusted to determine if random drift could be excluded as the cause of

changes in allele frequency, and differences were retested ($P < 0.29$) and ($P < 0.31$), respectively. Results for *FS2* were similar to those of *FS1*. The additive effect of the B allele of *FS1* on estimated breeding value for pigs born live in LS ($n = 207$) was +0.09. Marker-assisted selection has the potential to be highly advantageous in selection for lowly heritable and sex-limited traits, such as litter size. Changes in allele frequency to the exclusion of random drift were not detected; however, sufficient evidence exists to support further investigation of *follicistatin* as a candidate gene for litter size in pigs.

Key Words: Pigs, Reproduction, Selection

901 Detection of quantitative trait loci for growth, carcass, and meat quality traits in a Pietrain x (Large White x Landrace) line cross. N. Vukasinovic¹, F.-X. Du¹, L. A. Messer¹, J. C. Byatt¹, M. M. Lohuis¹, A. C. Clutter¹, J. Bennewitz², N. Reinsch², G. Otto², K. Sanders², N. Borchers², C. Looft², and E. Kalm², ¹*Animal AG Monsanto Company*, ²*Institute of Animal Breeding and Husbandry, Christian-Albrechts University of Kiel, Germany*.

An analysis of quantitative trait loci (QTL) affecting growth, carcass and meat quality traits in swine was conducted on an F₂ population created by crossing Pietrain boars with Large White x Landrace hybrid sows at Christian-Albrechts University of Kiel, Germany. Four F₁ sires were repeatedly mated to 33 full-sib F₁ sows to produce 1014 F₂ offspring. All F₀, F₁, and F₂ animals were genotyped for 27 microsatellite markers on chromosomes 2, 6, and 7. Data on eight growth traits (weights and daily gains at various ages), 16 carcass traits (hot carcass and ham weights and percentages, carcass length, loin eye area, and various fatness measurements), and seven meat quality traits (pH, meat color, and conductivity) were analyzed using line cross (LC) and half-sib family (HS) regression methods. LC analysis revealed very strong evidence ($P < 0.001$) of QTL for daily gain, hot carcass weight, and fatness traits (backfat thickness, abdominal fat, loin fat area, meat:fat ratio, and lean percentage) located near the proximal end of chromosome 2. Chromosome 2 also carried a significant QTL ($P < 0.001$) at 34cM for meat reflectance. The significant QTL in the proximal region of chromosome 2 were imprinted. There was a very significant QTL ($P < 0.001$) affecting carcass length around 90cM on chromosome 7. HS analysis of four large paternal families (each with 250 offspring) was performed to detect QTL segregating within the lines. HS analysis confirmed the QTL found by LC analysis. Additional significant QTL ($P < 0.01$) were found on chromosome 2 for ham weight and ham percentage at 2cM, and for loin pH at 113cM. There was suggestive evidence ($P < 0.05$) of several QTL affecting daily gain and fatness traits on chromosomes 6 and 7. These results indicate that some QTL segregate within, rather than between the lines.

Key Words: QTL Mapping, Line Cross, Half-Sib Analysis

902 An evaluation of meat and eating quality traits between pigs sired by boars from two different time periods. C. R. Schwab^{*}, T. J. Baas, D. W. Newcom, and K. J. Stalder, *Iowa State University, Ames*.

This study was conducted to evaluate differences in meat and eating quality traits between pigs sired by boars currently available and pigs sired by boars from the mid 1980's. Two lines were developed by splitting and randomly allocating littermate and $\frac{1}{2}$ sib pairs of females for matings by current (CTP) or old (OTP) time period boars. Matings by CTP boars were made using fresh semen and matings to OTP boars were made using frozen semen. Subsequent boar, barrow, and gilt progeny from two replications were weighed off test at a mean pen weight of 109 kg. All available barrows and randomly selected gilts were sent to a commercial abattoir and used for meat and eating quality evaluation. Records on pigs sired by CTP boars ($n=178$) were from 23 sires while pigs sired by OTP boars ($n=98$) were from 15 sire groups. Chemical intramuscular fat percentage was determined by lab analysis of a sample from the loin at the 10th rib. Additional meat and eating quality traits measured were: Minolta reflectance and Hunter L color (24 and 48 h); pH (24 h and 7 d); water holding capacity and subjective visual scores for color, marbling, and firmness (48 h); Instron tenderness, cooking loss, and trained sensory panel evaluations (7 d). Time period differences were assessed by the use of a mixed model that included fixed effects of sire time period, replication, sex, contemporary group, and the interaction of sex by time period. Sire and dam nested within time period were included as random effects. Pigs sired by OTP boars had a greater

($P < 0.05$) intramuscular fat percentage and higher subjective marbling and color scores than pigs sired by CTP boars. There were no differences between time periods for the evaluations of Minolta reflectance, Hunter L (24 and 48 h), water holding capacity, Instron tenderness, pH (24 h and 7 d), or subjective firmness scores. Trained sensory evaluations revealed higher ($P < 0.05$) flavor scores and lower off-flavor scores for OTP sired pigs; however, no differences in tenderness score, juiciness score, chewiness score, or cooking loss were found between the two lines.

Key Words: Swine, Meat Quality, Eating Quality

903 Growth and carcass composition in pig lines divergently selected for testosterone production and their crossbred progeny. J. M. Bender^{*} and J. P. Cassady, *North Carolina State University, Raleigh*.

The objective of this study was to characterize growth and carcass composition in two Duroc lines of pigs divergently selected 10 generations for testosterone production and then maintained by random within line selection. In generation 21 endogenous testosterone production in the high (HTL) and low (LTL) testosterone lines averaged 49.0 ng/ml and 27.8 ng/ml ($P < 0.01$), respectively. Eight LTL and 10 HTL boars were used to create 29 LTL and 33 HTL litters. These same boars were mated to a common line of white composite (WC) females to generate 11 WC by LTL litters (WLT) and 23 WC by HTL litters (WHT). Barrows and gilts were then selected LTL ($n=55$), HTL ($n=61$), WLT ($n=102$), and WHT ($n=101$) for testing. Pigs were weighed and scanned using real-time ultrasound 48 h prior to one of two slaughter dates. Data were analyzed with a mixed model including fixed effects of genetic group, slaughter date, sex, and random effect of sire nested within line. All possible interactions among fixed effects were tested. Traits analyzed included days to 114 kg (D114), average daily gain (ADG), back fat adjusted to 114 kg (BF114), loin eye area adjusted to 114 kg (LEA), predicted percent lean (%LEAN) and marbling 24 h post-mortem. Lines did not differ for LEA. The HTL had fewer D114 ($P < 0.011$), greater ADG ($P < 0.004$), greater BF114 ($P < 0.001$), and lower %lean ($P < 0.001$) than LTL. For crossbred progeny WHT had greater ADG ($P < 0.010$) and greater BF114 ($P < 0.025$) than WLT and tended to have fewer D114 ($P < 0.068$) and lower %lean ($P < 0.08$) than WLT. Least square means for marbling score for HTL, LTL, WHT, and WLT were 3.63, 3.61, 3.03, and 3.03, respectively. Pure line progeny were more highly marbled than crossbred progeny ($P < 0.01$). Pigs selected for increased testosterone production grew faster and produced fatter carcasses than pigs selected for decreased testosterone. Because of their high marbling scores these lines may be useful in developing premium products.

Key Words: Growth, Carcass Composition, Pigs

904 Detection of quantitative trait loci segregation within pure breeds in a Berkshire x Yorkshire F₂ population. H. Zhao^{*}, J.-J. Kim¹, M. Perez-Enciso², and J. C. M. Dekkers¹, ¹*Iowa State University, Ames*, ²*Universitat Autònoma de Barcelona, Spain*.

Segregation of quantitative trait loci (QTL) within commercial breeds is of great interest because most marker-assisted selection is implemented within breeds. The objective here was to implement a variance component analysis method to detect and characterize QTL in an F₂ cross between two Berkshire grand sires and nine Yorkshire grand dams with data on 525 F₂ progeny. A model that combines fixed between-breed and random within-breed QTL effects and random polygenic effects was used to analyze back fat traits on chromosomes 7 and 12. These chromosomes were partitioned into segments based on previous results from QTL mapping using least squares regression: 0-35, 35-65, 65-95, 95-125 and 125-138 cM for chromosome 7, and 0-45, 45-80 and 80-96 cM for chromosome 12. For each segment, identity by descent probabilities were obtained by a Monte Carlo Markov Chain algorithm. Each segment was first tested separately for presence of a QTL effect, by comparing the full model with a model with only the polygenic effect, and for segregation of the QTL within the parental breeds, by dropping the variance of the segment. All significant segments were then fitted in a full model and tested vs. a reduced model where the effects of one segment were dropped. For chromosome 7, segments 35-65 cM and 95-125 cM had significant ($p < 0.05$) effects on average backfat, tenth rib backfat and lumbar backfat. The variance of segment 35-65 cM was significant for average backfat and lumbar backfat. Both fixed and random effects were significant for segment 65-95 cM for last rib backfat. For chromosome

12, segment 0-45 cM was significant for average backfat and last rib backfat without significant variance. In conclusion, multiple and segregating QTL were detected for backfat traits on chromosome 7 and QTL was detected on one segment on chromosome 12. The variance component approach is a useful method to detect QTL in crosses between outbred breeds and to identify those that segregate within breeds.

Key Words: QTL, Segregation, Variance Component Analysis

905 PACE: An integrated pig genome database. J. W. M. Merks^{*1}, T. J. A. van Kampen², R. van Wijk¹, B. Harlizius¹, A. Rattink³, G. Albers³, and M. A. M. Groenen², ¹IPG, Institute for Pig Genetics BV, Beuningen, The Netherlands, ²Department of Animal Sciences - Animal Breeding and Genetics Group, Wageningen University and Research Centre, Wageningen, The Netherlands, ³Nutreco Breeding Research Centre, Boxmeer, The Netherlands.

Knowledge of farm animal genomes has increased enormously over the last decade. A large part of this information is publicly available for a variety of species and through specific databases such as for pigs; PiG-BASE for mapping data, Pig EST Database, TIGR SsGI for genes and data on their expression patterns and the INRA Comparative and Cyto-genetic mapping home pages. Potentially these databases provide comprehensive public repositories for genome research. However, these data are difficult to combine from the different sources or with private data, but also with genome data of model organisms. This strongly hinders comparative mapping and positional fine-mapping. A new pig genome database - PACE was set up in the Netherlands to enable integration of data from the different sources. For this, the widespread database system of AceDB has been adapted and links with existing farm animal databases but also databases like LocusLink, Genbank, MGI, GeneCards are included to facilitate an efficient comparative mapping with human and mouse. In addition published information on porcine QTL has been included. This database with more than 5000 genetic markers and loci and about 500 QTL's will be available publicly from July 2004.

Key Words: Pigs, Genome Map, Database

906 Estimation of genetic parameters for farrowing mortality, litter size and test performance of first parity Large White sows. J. Arango^{*1}, I. Misztal¹, S. Tsuruta¹, M. Culbertson², and W. Herring², ¹University of Georgia, Athens, ²Smithfield Premium Genetics, Roanoke Rapids, NC.

Selection to increase prolificacy and performance traits may be affecting piglet survivability at different production stages. To investigate this complex of traits, genetic correlations were estimated among total born (TB), number born alive (BA) and number of pigs born dead (PD) from 47,454 first-parity Large White sow records. Data were from 22 pure-line farms. Additional performance data (n=30,832) were available for ultrasound backfat (BF) at end of the test, and days to reach 113.3 kg (AD). Univariate, all pair-wise bivariate, and four sets of trivariate (TB-PD-AD, TB-PD-BF, BA-PD-AD and BA-PD- BF) analyses were carried out using AI-REML. Models included the fixed effects of contemporary group (farm-farrowing year-farrowing month for litter traits

and batch-sex-farm-barn for test traits). Analysis of BF included measurement weight as linear and quadratic covariates. Random effects of animal additive genetic and residual error were also included. Estimates of heritability averaged over analyses were 0.09, 0.08, 0.06, 0.37 and 0.31 for TB, BA, PD, AD and BF, respectively, and were similar across individual analyses. Estimates of genetic correlations averaged over analyses were 0.94, 0.39, 0.03, -0.02 for TB-BA, TB-PD, TB-AD and TB-BF; 0.02, 0.08 and 0.06 for BA-PD, BA-AD and BA-BF; -0.13 and -0.21 for PD-AD and PD-BF, and -0.23 for BF-AD, respectively. The genetic relationship of PD with TB was moderate and positive while negative with AD and BF. Response to selection for increasing litter size may increase piglet mortality at birth. Intense selection for faster growth and increased leanness may increase piglet mortality from first parity sows in this population.

Key Words: Swine, Farrowing Mortality, Litter Size

907 Comparison of deposition rates for loin muscle area, backfat, and intramuscular fat percentage among breeds in the 2003 National Barrow Show Sire Progeny Test. B. D. Martin^{*}, T. J. Baas, C. Schwab, D. W. Newcom, J. F. Lampe, and K. J. Stalder, Iowa State University, Ames.

Weights and serial ultrasonic measurements of 10th rib loin muscle area (LMA), 10th rib backfat (BF), and intramuscular fat percentage (IMF) were used to assess deposition rates and growth patterns of purebred pigs entered in the National Barrow Show Sire Progeny Test. Yorkshire (30), Duroc (71), Chester White (49), and Berkshire (154) barrows and gilts were weighed and scanned for LMA, BF, and IMF every two weeks beginning at a live weight of approximately 68 kg. Off test ultrasonic measurements were taken at approximately 109 kg. Five scans were taken on each animal. At each scan period, BF, LMA, and IMF were analyzed with a mixed model that included fixed effects of breed, sex, contemporary group, and the interaction of breed by sex. Sire and dam within breed were included as random effects. Weight at each scan period was included as a linear covariate. Deposition rates were calculated for LMA, BF, and IMF using intra-pig linear and quadratic regressions for the independent variable live weight. Intra-pig linear and quadratic regression coefficients and y-intercepts were analyzed as dependent variables in a mixed model that included fixed effects of breed, sex, contemporary group, and the interaction of breed by sex. Across all scans, Yorkshires and Durocs were significantly leaner than Berkshires, and gilts were leaner than barrows. At scans 3, 4, and 5, Durocs were significantly leaner and had more (P<0.05) LMA than Chester Whites. Durocs had more (P < 0.05) LMA than Yorkshires and Berkshires at all five scan periods. Chester White pigs had the largest linear regression coefficient for LMA and the smallest y-intercept. Mean deposition rates for IMF were not significantly different between breeds. Gilts had more (P < 0.05) LMA than barrows at periods 3, 4, and 5. Barrows had more (P < 0.05) IMF than gilts at scan intervals 2, 3, 4, and 5. Quadratic regression coefficients for BF were significantly different between barrows (-0.00002) and gilts (-0.00001).

Key Words: Swine, Ultrasound, Regression

Nonruminant Nutrition: Feed Ingredients & Management

908 Effect of whey and lactose source on nursery pig performance. A. M. Gaines^{*}, B. W. Ratliff, P. Srichana, and G. L. Allee, University of Missouri, Columbia.

A 25 d growth assay experiment was conducted to determine the effects of whey and lactose source on nursery pig performance. At weaning, a total of 276 pigs (TR-4 × C22; 5.8 ± 0.03 kg) reared in a commercial research facility were fed one of two diets containing spray-dried whey and crystalline lactose or granular whey and Dairy Lac 80[®]. Pigs were housed 23 pigs per pen and fed in three dietary phases. Each diet contained the same inclusion of whey and other specialty ingredients. Diets were formulated to be lactose equivalent with additional lactose being added from crystalline lactose in the spray dried whey diets or Dairy Lac 80[®] in the granular whey diets. For the phase 1 period (0-7 d), phase 2 period (7-14 d), and phase 3 period (14-25 d) the level of inclusion of whey in the diets was 20.0%, 10.0%, and 0.0%, respectively. A whey source was not included in phase 3; however, both the spray-

dried and granular whey treatments did contain 7% lactose derived from crystalline lactose or Dairy Lac 80[®], respectively. During the Phase 1 period there was no effect of whey and lactose source on ADG (P = 0.91), ADFI (P = 0.29), or G/F (P = 0.54). Similarly, there was no effect of whey and lactose source on ADG (P = 0.57), ADFI (P = 0.37), or G/F (P = 0.63) during the Phase 2 period. However, during the Phase 3 period pigs fed Dairy Lac 80[®] had improved ADG (P = 0.07) as compared to pigs fed crystalline lactose. Improvements in ADG were due to improvements in ADFI (P = 0.08). There were no differences in G/F (P = 0.76) among the lactose sources. For the overall period (d 0-25) pigs fed granular whey and Dairy Lac 80[®] had improved ADG (P = 0.05) and ADFI (P = 0.04) as compared to pigs fed spray-dried whey and crystalline lactose. There were no differences in G/F (P = 0.44). Based on the results, whey and lactose source did not influence growth performance during the early nursery period. However, growth perfor-

mance in the Phase 3 period was improved when the diets contained Dairy Lac 80[®].

Key Words: Pigs, Whey, Lactose

909 Effect of specialty protein supplements on nitrogen balance and digestibility in weanling pigs. J. Zhao*, A. F. Harper, K. E. Webb, Jr., and M. E. Estienne, *Virginia Polytechnic Institute and State University, Blacksburg.*

Inclusion of spray-dried plasma protein (SDPP) in diets for early-weaned pigs improves post-weaning growth. The objective of this experiment was to determine the effects of supplemental SDPP and a marine-based hydrolyzed protein source (Peptiva, VITECH BIOCHEM, San Fernando, CA) in weanling pig diets on N balance and digestibility. At weaning, pigs (n = 48, 5.4 kg BW, and 17 d of age) were placed in metabolism cages with two pigs per cage. There were three dietary treatments (8 cages/treatment): a corn-soy-whey control diet or similar diets containing 6% SDPP or 6% Peptiva. Diets were formulated to be equivalent in energy and essential amino acids. A 7-d adjustment period was followed by two 5-d collection periods, during which total feces, urine, and orsts were collected. Pigs were fed their respective diets in two equal portions at 12-h intervals to give daily intake of approximately 3% of BW. Dry matter content of feed and fecal samples was determined by oven drying. Nitrogen concentration of feces, feed and urine was determined by the Kjeldahl method. Analytical data were used to calculate DM and protein digestibility and N balance. Supplementation of 6% SDPP or 6% Peptiva had no impact on protein digestibility, retention, or biological value of the diet. Percent absorbed N ranged from 88.51 to 89.34%, and was not different among treatments (P = 0.55). Similarly, percent N retention ranged from 69.08 to 72.01, and was not different among treatments (P = 0.39). The calculated percent biological value and DM digestibility were: 80.92 and 91.51, 77.62 and 92.01, and 78.03 and 91.28 for the control, SDPP and Peptiva treatments, respectively, with no difference among treatments (P = 0.22 to 0.39). In summary, inclusion of SDPP or Peptiva in the diet of weanling piglets did not alter digestibility, N balance or biological value of protein. Situations in which supplementation of these products improves performance appear unrelated to effects on N digestibility or N balance.

Key Words: Digestibility, Nitrogen Balance, Pigs

910 Use of rice in substitution of corn in diets for young pigs. B. Vicente¹, D. G. Valencia¹, R. Lázaro*¹, M. A. Latorre², and G. G. Mateos¹, ¹*Universidad Politécnica de Madrid, Spain*, ²*Universidad Cardenal H. Oria CEU, Spain*.

We studied the influence of the cereal portion of the diet on performance and total tract nutrient digestibility (TTFD) of young pigs. Control pigs received a practical feeding program based on a complex diet without antibiotics that included 50% of cooked corn (99 C during 50 min and then rolled) from 25 to 39 d of age and a corn-soybean meal diet from 39 to 53 d of age. The experimental groups received the same complex diet as the control group but corn was substituted by rice either raw, cooked, or cooked and rolled from 25 to 53 d of age. The percentage of starch gelatinization was 56% for cooked and rolled corn, 14% for raw rice, 25% for cooked rice, and 48% for cooked and rolled rice. Each treatment was replicated eight times (five piglets penned together). Digestibility of nutrients was determined at 27, 39, and 53 d using 0.6% celite as an indigestible marker. From 25 to 39 d piglets fed rice ate more feed (481 vs 391 g/d; P<0.001), grew faster (357 vs 277 g/d; P<0.001), and tended to have better feed conversion (1.34 vs 1.42 g/g; P<0.10) than piglets fed corn. Similar results were observed at the end of the trial. No significant differences in performance were observed among piglets fed the three rice diets but piglets fed cooked rice grew 6.3% faster and had 6.1% better feed conversion than piglets fed raw rice. At 27 d of age TTFD of DM, OM, and GE was lower for corn (P<0.001) than for rice diets, but nitrogen retention was the same. Piglets fed heat processed rice tended to have better TTFD of nutrients than piglets fed raw rice but the differences disappeared with age. It is concluded that rice improves piglet performance from 25 to 53 d and nutrient digestibility at 27 d. No differences were observed between cooked and cooked and rolled rice in spite of differences in percentage of starch gelatinization, indicating that the beneficial effects of heat processing of rice on

piglet performance and nutrient digestibility were independent of starch gelatinization.

Key Words: Rice, Piglet Performance, Heat Processing

911 Growth and carcass characteristics of pigs fed biotechnologically derived and non-biotechnologically derived corn and harvested at different weights. M.G. Custodio*¹, W.J. Powers¹, E. Huff-Lonergan¹, M.A. Faust², and J. Stein³, ¹*Iowa State University, Ames*, ²*ABS Global, Inc., DeForest, WI*, ³*Syngenta Biotechnology, Inc., Research Triangle Park, NC*.

To compare growth performance and carcass characteristics, 64 pigs (average initial BW = 62 kg) were fed diets containing biotechnologically derived corn (Bt: Syngenta Bt 11 event) or control corn (C: pooled non-biotechnologically derived inbred lines). Pigs were blocked by sex and weight and allocated to 16 pens. Iso-caloric, isonitrogenous diets contained an indigestible marker. Feed and water were provided ad libitum. Feed disappearance and weight gain data, and fecal samples were collected weekly. At slaughter, pigs were divided into two groups based on market weight: 1 (85 kg) and 2 (110 kg). No difference in ADG was observed between pigs fed C and Bt diets for harvest weight groups. Feed efficiency was greater for pigs fed the C diet (P = 0.002) and was not different between groups 1 and 2 pigs. An interaction between corn and harvest weight was observed. No corn effects were observed for hot carcass weight, loin eye area (LEA), and 1st, 10th, last rib, and last lumbar vertebrae fat. Harvest weight differences were observed; lighter weight pigs had smaller LEA (12.4 vs. 15.7 cm²; P < 0.001) and less backfat. Across both market weight groups, gilts had larger LEA (P < 0.05) and were leaner than barrows. No harvest weight and corn source effects were observed for meat tenderness and drip loss. Hunter color *L*/*b* values were greater for pigs fed C diets (11.71 vs. 11.31; P = 0.02) and group 2 pigs (11.77 vs. 11.26; P = 0.005). There were no significant differences in DM, ether extract or CP content of meat samples. No corn effects were observed for N or P content of fecal samples. There were no differences in apparent digestibility of N between pigs fed Bt and C diets. Pigs fed C diets had greater apparent P digestibility (57.8% vs. 40.2%; P < 0.001). Interactions were observed between treatment and sex; barrows fed Bt corn and gilts fed C corn had lowest apparent P digestibilities. Findings suggest no detrimental effects on growth performance or carcass and excretion characteristics for growing-finishing pigs fed Bt corn. Traits desired by consumers were not different between pigs harvested at light and heavy market weights.

Key Words: Pigs, Biotechnologically Derived Corn, Carcass Characteristics

912 Nutritional value of a corn containing a glutamate dehydrogenase gene for growing pigs. G. A. Apgar*¹, T. A. Guthrie¹, K. E. Griswold², M. P. Martin¹, J. S. Radcliffe³, and M. D. Lindemann⁴, ¹*Southern Illinois University, Carbondale*, ²*Penn State University Extension, Lancaster*, ³*Purdue University, West Lafayette, IN*, ⁴*University of Kentucky, Lexington*.

Eight female PIC pigs (initial body wt. 47.5 ± 1.8 kg) were utilized in a two period switchback design (n = 4 per treatment per period) to evaluate the nutritional difference between a genetically modified corn and a similar non-transgenic corn. The genetically altered corn (*gdhA+*) contained a glutamate dehydrogenase gene isolated from *Escherichia coli*. The non-transgenic corn was the same variety lacking the transgenic cassette, grown at the same locations. Pigs were surgically fitted with steered ileo-cecal valve cannulas for collection of ileal digesta. Diets were comprised primarily of one of the two corn sources. Dietary AA profiles were adjusted using crystalline AA to match Illinois Ideal Protein Ratios. Pigs were limit fed at 8% of metabolic body weight (BW^{0.75}), in two equal feedings at 0600 and 1800 each day throughout the experiment. The study consisted of two 15-d periods. Each period was comprised of a 7-d acclimation period, a 3-d total collection of feces and urine, two 12-h ileal collections, and a 3-d adjustment period between ileal collections to assure adequate hydration. Crude protein, leucine, methionine, alanine, aspartic acid, glutamic acid and tyrosine concentrations were greater (P < 0.05) in the *gdhA+* corn when compared with the non-transgenic variety. The presence of the gene did not alter (P > 0.17) body weight gain, nor (P > 0.32) dry matter digestibility, fecal N excretion (g/d), apparent total tract N digestibility, N balance, net protein utilization, or N retained as % of absorbed. Apparent ileal AA digestibility values did not differ (P > 0.31) between

the two dietary treatments. This study showed corn that contains the *E. coli* gene for glutamate dehydrogenase was nutritionally equivalent to the non-altered variety.

Key Words: Maize, Transgenics, Pigs

913 The digestive fate of the *gdhA* transgene in corn diets fed to weanling swine. J. M. Beagle*¹, G. A. Appgar¹, K. L. Jones¹, K. E. Griswold², X. Qui¹, and M. P. Martin¹, ¹*Southern Illinois University, Carbondale*, ²*Penn State Extension, Lancaster*.

A transgenic corn containing *E. coli* glutamate dehydrogenase (*gdhA*) was used in diets fed to weanling swine and the digestive fate of the *gdhA* transgene was traced. Eight groups of 8 pigs were fed a commercially available (non-*gdhA*) starter feed for 2 wk. One pig was randomly selected from each pen, sacrificed, and negative control samples were collected. The remaining 56 pigs were fed a diet containing 57.97% *gdhA* corn for 2 wk. All pigs were then sacrificed and treatment samples were collected. Samples from both control and treatment pigs included digesta from the stomach, distal ileum, and distal colon, liver, 10th rib muscle, and white blood cells and plasma from the hepatic portal vein. Total genomic DNA was extracted and concentration determined via spectrophotometry. Polymerase chain reaction (PCR) was performed with primers designed to amplify a 456 bp region of the *gdhA* gene, and PCR products were analyzed using gel electrophoresis. DNA extracted from the *gdhA* positive corn acted as a positive control for the PCR and gel electrophoresis while DNA extracted from a commercially available non-*gdhA* corn and an equivalent volume of distilled water acted as negative controls. DNA extracted from the *gdhA* positive diet ensured the transgene was detectable in the diet. The level of detection allowed as little as 0.3 ng transgenic corn DNA per each 20 ul reaction to be detected even when confounded with 6.4 ug of SBM or 1.5 ug non-*gdhA* corn. The 456 bp region of the *gdhA* transgene was detected in 71% of the stomach digesta samples from treatment animals, but was not detected in the small and large intestine, WBC, plasma, liver, or muscle samples. No transgenic DNA was detected in any sample from control animals. These data suggest that degradation of this transgene began in the stomach and that the transgene was degraded beyond detection by the time the digesta reached the distal ileum.

Key Words: Glutamate Dehydrogenase, Transgenic, Corn

914 Effects of increasing pantothenic acid on growth performance and carcass characteristics of finishing pigs reared in a commercial environment. C. N. Groesbeck*, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. L. Nelssen, and J. M. DeRouchey, *Kansas State University, Manhattan*.

An experiment using 1,080 pigs (PIC, initially 40.3 kg) was conducted to evaluate added pantothenic acid (PA) on growth performance and carcass characteristics. Pigs were blocked by weight and gender, and were randomly allotted to one of four dietary treatments. There were 10 pens per treatment with a mean of 27 pigs per pen. Pigs were fed the experimental corn-soybean meal, 5% added fat diets in four phases. Pigs were fed the control diet (no added PA) or the control diet with 22.5, 45 or 90 ppm of added PA from d-calcium pantothenate. Pigs were fed the assigned dietary treatments from 40.3 to 123.6 kg (d 0 to 98), and transported to a commercial packing facility to collect carcass measurements. Pigs were weighed and feed intake was determined every 14 d. There were no PA gender interactions ($P > 0.05$) observed. Increasing dietary PA had no effect ($P > 0.05$) on ADG, ADFI, or feed efficiency (G/F) from d 0 to 98. Barrows had greater ($P < 0.01$) ADG and ADFI than gilts. Increasing pantothenic acid has no effect ($P > 0.05$) on hot carcass weight, dressing percent, fat free lean index (FFLI), average backfat, and loin depth. Gilts had less ($P < 0.001$) backfat and a greater ($P < 0.001$) FFLI than barrows. There were no ($P > 0.05$) gender differences in dressing percent or loin depth. Increasing dietary pantothenic acid during the grow-finish phase does not appear to provide any advantage in growth performance or carcass composition of commercially reared finishing pigs.

Item ^a	0.0	22.5	45.0	90.0	SE
Average wt, d 98	123.11	123.12	122.36	123.76	1.05
ADG, kg	0.85	0.84	0.85	0.87	0.01
Gain/Feed	0.37	0.36	0.36	0.37	0.01
Fat free lean index	50.42	50.36	50.05	50.29	0.19
Average backfat, mm	17.22	17.12	17.65	17.50	0.40

^aNo differences ($P > 0.05$)

Key Words: Pigs, Growth, Pantothenic Acid

915 Effects of reduced crude protein and fiber supplementation on nitrogen and phosphorus digestibility and manure generation. D. M. Sholly*, S. L. Hankins, M. C. Walsh, A. L. Sutton, and B. T. Richert, *Purdue University, West Lafayette, IN*.

Sixteen crossbred barrows (avg initial BW = 32.6 kg) were allotted by weight to 4 experimental diets (4 pigs/diet) in a 2 x 2 factorial design comparing two crude protein (CP) levels and 0 or 10% wheat bran (WB). Dietary trts were: 1) Control (CTL), 17.7% CP; 2) CTL + 10% WB; 3) Low Nutrient Excretion diet (LNE), 13.9% CP, HAP corn, phytase, and synthetic amino acids; and 4) LNE + 10% WB. A 28 d experiment included a 5 d adjustment period to metabolism pens, a 20 d collection of total feces and urine (3 times/wk) for storage in 16 individual PVC columns (122 x 38 cm), and a 3 d total collection to determine nutrient digestibility. There were no differences in initial and final BW among dietary trts. Inclusion of WB decreased ADFI (4.00 vs. 3.66 kg/d; $P < .007$) by 8.5%. Manure generation (as-is basis) was not different among dietary trts. LNE diets reduced manure DM (kg/d) ($P < .004$) by 18.2%, however, WB inclusion increased manure DM (kg/d) by 12.5% ($P < .02$). Manure pH (avg 6.91) was not affected by dietary CP or WB. LNE diets tended to decrease total N (TN) concentration (as-is basis) in the stored manure by 20% ($P < .09$). Manure TN concentration (DMB) was decreased ($P < .0001$) by 14.6% and 21% for the LNE diets and 10% WB inclusion, respectively. Manure ammonium N (AmmN; DMB) concentration was decreased by 22.4% with WB ($P < .003$). The LNE diets decreased ($P < .003$) stored manure total P (TP) concentration (as-is basis) by 38% and TP excreted by 48.2% (4.25 vs. 2.2 g/d; $P < .0001$) when compared to CTL diets. Dietary trts did not affect N and P digestibility. LNE diets reduced total AmmN excreted by 35.5% (3.03 vs. 1.96 g/d; $P < .002$), fecal TP (5.61 vs. 3.67 g/d; $P < .002$) by 34.6%, and total WSP (3.76 vs. 1.74 g/d; $P < .0005$) by 54%. The use of reduced dietary CP and P diets can significantly reduce the amount of N and P excreted by growing pigs. The inclusion of 10% WB did decrease N and AmmN excretion, but also decreased pig ADFI which may hinder growth performance.

Key Words: Pigs, Crude Protein, Fiber

916 Comparison of models fitted to electronically recorded swine growth data over a limited test period. G. Vander Voort* and C. F. M de Lange, *University of Guelph, Guelph, ON, Canada*.

The evaluation of alternative management, marketing and breeding strategies in pork production systems requires knowledge of variation in pig growth patterns. The objective of this research was to evaluate alternative mathematical functions and statistical procedures to represent growth patterns (BW vs time) of individual pigs between about 25 to 120 kg BW. Electronically recorded daily BW data from an 84 d period for 40 group-housed pigs was analyzed. Data was filtered to identify and edit outliers. Three functions (modified Bridges, Gompertz, and exponential second order polynomial) were fit for each individual pig using the non-linear procedure of SAS. A second order polynomial was also fit for each individual pig using a random regression procedure. Least square means of residuals (RESls) for daily BW were calculated for each function and 21 d interval of the test period. Across intervals, the smallest RESls were observed for the random regression derived second order polynomial (-0.16 to -0.01 kg; SE 0.11), these values did not differ from zero and across 21 d interval ($P > 0.10$). For the other functions, RESls differed from zero ($P < 0.05$) for at least one 21 day interval. For the Gompertz function and d 63 to 84 of the test period, the absolute RESls was largest (-1.04 kg; SE 0.12), indicating a systematic bias in the prediction of BW during the last 21 d of the

test period when using this function. Based on analysis of residual patterns, the Bridges, Gompertz, and exponential second order polynomial functions were more sensitive to violation of the assumption of constant residual variance across time. The least amount of bias in the representation of the growth patterns of pigs was observed when using a random regression procedure and a second order polynomial function.

Key Words: Swine, Growth, Function

917 Processing of western Canadian feed ingredients improves their digestibility in Nile tilapia (*Oreochromis niloticus*). T. L. Borgeson*, D. L. Thiessen, V. J. Racz, and M. D. Drew, *University of Saskatchewan, Saskatoon, SK, Canada.*

The apparent digestibility coefficients (ADC) of unprocessed and processed pea, canola and flax products were determined on diets, in which 30% of a reference diet was replaced by each test ingredient. Celite was used as an indigestible marker for measuring apparent digestibility coefficients indirectly. The trial was conducted in a semi-closed recirculating system using 5 tanks per diet with 40 fish per tank, and feces were collected using a settling column. The processed ingredients included dehulled flax produced by abrasive dehulling, canola protein concentrate and pea protein concentrate, which were produced by aqueous extraction of peas and canola meal, respectively. Coextrudates of canola and peas (C:P) or flax and peas (F:P) were also tested. Processing had no significant effect on the ADC of crude protein except for flax. Whole flax

had negative ADC for crude protein, energy and dry matter probably due to the high viscosity of this diet. Processing significantly improved the ADC of energy and dry matter for pea, canola meal and flax ($P < 0.05$). The ADC for crude protein for C:P was not significantly different than pea or canola meal while the ADC for crude protein for F:P was intermediate between flax and pea. The coextruded products had ADC for energy and dry matter that were significantly higher than those of the component ingredients ($P < 0.05$). The results suggest that these processing methods can significantly improve energy and dry matter ADC of pea, canola and flax by tilapia but have less effect on protein digestibility.

Ingredient	Crude protein	Energy	Dry Matter
Pea	0.86 ^a	0.58 ^{cd}	0.59 ^{cde}
Pea protein concentrate	0.95 ^a	0.95 ^a	0.93 ^a
Canola meal	0.82 ^a	0.68 ^{bc}	0.54 ^{de}
Canola protein concentrate	0.86 ^a	0.84 ^{ab}	0.78 ^{abc}
Extruded canola:pea	0.76 ^{ab}	0.84 ^a	0.69 ^{bcd}
Whole flax	-0.38 ^d	-0.27 ^e	-0.45 ^f
Dehulled flax	0.46 ^c	0.48 ^d	0.41 ^e
Extruded flax:pea	0.61 ^b	0.53 ^{cd}	0.41 ^e

^{a-f} $P < 0.05$ within columns.

Key Words: Feed processing, Digestibility, Tilapia

Physiology and Endocrinology: Stress and Inflammation: Effects on Animal Performance

918 Performance of gilts housed individually in stalls or in groups in pens during the first 30 d post-mating. M. J. Estienne*, A. F. Harper, and J. W. Knight, *Virginia Polytechnic Institute and State University, Blacksburg.*

In the U.S. most sows are individually housed throughout gestation in stalls that allow only standing, sitting and lying. Use of gestation stalls is a contentious welfare issue that may lead to legislation limiting the housing of sows in stalls to a defined interval that is less than the total gestation period. The objective was to assess performance of gilts housed individually in stalls or in groups in pens for the first 30 d after mating. Gilts ($n = 56$; 159.5 ± 1.5 kg BW; 15.0 ± 0.5 mm backfat) were mated via AI twice during estrus. After the second AI, gilts were placed in stalls (0.6×2.0 m) ($n = 14$) or pens (1.7×3.1 m) containing three gilts each ($n = 14$), and were fed at a rate of 2 kg/gilt/d. Gilts housed in pens gained more BW than gilts housed in stalls (11.0 vs. 6.7 kg; SE = 0.8; $P < 0.01$), but change in backfat was similar between treatments (-0.3 vs. -0.4 mm; SE = 0.5; $P = 0.80$). The proportion of gilts exhibiting stereotypies on d 28 was not affected by treatment (81 for groups vs. 93% for stalls; SE = 7.2; $P = 0.26$). Wound scores (0 to 5; 5 = severe) were greater for group-housed gilts and were greatest during the first 7 d post-mating. For example, wound scores for the head, face and ears (2.5 vs. 1.3; SE = 0.2) and neck and shoulders (2.6 vs. 0.3; SE = 0.2) on d 3 were greater ($P < 0.01$) for group- vs. stall-housed gilts. Lameness scores (0 to 5; 5 = severe) on d 30 were greater in group- compared to stall-housed gilts (0.6 vs. 0.2; SE = 0.1; $P = 0.06$). Pregnancy rate at d 30 was lower ($P < 0.01$) for group- compared to stall-housed gilts (85.7 vs. 100%; SE = 3.2). Following slaughter at d 30 of gestation, the number of embryos (13.8 vs. 15.5; SE = 1.8; $P = 0.51$), embryo weight (1.59 vs. 1.58 g; SE = 0.07; $P = 0.89$) and crown-rump length (27.2 vs. 27.1 mm; SE = 0.46; $P = 0.92$) were similar for group- and stall-housed gilts, respectively. Indicators of welfare were differentially affected by type of gestation housing and pregnancy rate was maximized in gilts housed individually in stalls.

Key Words: Gestation, Housing, Gilt

919 Effects of stress and genotype on immune and cortisol measures in pigs. M. A. Sutherland*, S. R. Niekamp, S. L. Rodriguez-Zas, and J. L. Salak-Johnson, *University of Illinois, Urbana.*

Pigs are exposed to many stressors during common management and production practices. Genotypic differences in immune measures and cortisol concentration in pigs have been reported but the influence of genotype on stress responsiveness is limited. The objective of this experiment was to determine the effect of "breed" and commercial genotypes

on immune and cortisol responses in pigs subjected to multiple stressors over 14 d. Piglets from Landrace Cross ($n=36$), Meishan ($n=30$), Yorkshire ($n=32$) and two commercial lines (LineA and LineB; $n=36$) were weaned at 17 to 21 d and kept in a common nursery environment. At 6 wk of age pigs were assigned either no stress (control) or stress (heat, crowding, mixing) treatment. Blood samples were obtained via veni-puncture at d 0 (baseline), 1, 7 and 14 post-stress to determine white blood cell counts, differentials, cortisol (CORT), IgG, lymphocyte proliferation (LPA), natural killer cytotoxicity (NK), phagocytosis and antibody response to sheep red blood cells. There were significant genotype and genotype x day interaction effects for CORT and numerous immune measures. CORT levels were lower ($P < 0.0001$) in stressed pigs compared to controls. At d 7, CORT levels were lower ($P < 0.05$) in stressed Meishans and Yorkshires compared to controls and remained suppressed in Meishans until d 14 ($P < 0.01$). LPA response was higher ($P < 0.05$) in stressed Meishans at d 1, and remained elevated until d 14, compared to control pigs ($P < 0.05$). NK, at E:T ratio of 25:1, was higher ($P < 0.05$) in Landraces and Yorkshires at d 14 compared to control pigs. In commercial lines, CORT levels were lower ($P < 0.05$) in stressed pigs compared to their controls at d 7. LPA response was higher ($P < 0.01$) in stressed LineA pigs at d 1 compared to control pigs. These results indicate a genotype effect on immune and cortisol concentrations in response to stress and that these effects change over time.

Key Words: Immune, Pigs, Genotype

920 The use of a Hens' Odorant Analogue to control stress consequences in Broilers. I. Madec^{*1}, J. F. Gabarrou², A. Bruneau¹, L. Bougrat¹, D. Saffray¹, B. Silliant³, and P. Pageat¹, ¹*Pherosynthese, Saint Saturnin Apt, France*, ²*Esa Purpan, Toulouse, France*, ³*Env Nantes, Nantes, France.*

In poultry, stress has consequences such as pecking behavior, increased feed to gain ratio, high mortality or bad carcass quality. Indicators of stress include: high H/L (Heterophil/Lymphocyte) ratio and elevated corticosterone secretion. We have identified in the uropygial glands in laying hens a secretion (named HOA: Hens Odorant Analogue, under patent). To test the hypothesis that HOA has stress-preventive actions and improves general performance, a trial was conducted (HOA vs control) using two similar buildings, each housing 24,000 chickens. Chickens were maintained on the ground floor under similar conditions. Males were separated from females. The HOA was administered by passive diffusion in the building atmosphere (one diffuser for 1000 chickens). After treatment, HOA-treated animals were heavier than controls: 2.22

vs 2.06 ($p < 0.0001$) for males and 1.13 vs 1.09 ($p < 0.0001$) for females. Percentage of scratched animals was lower in the HOA treated group than in controls: 8% vs 22% ($p < 0.001$) for males, 10% vs 19% ($p < 0.001$) for females. Results concerning suffocated chickens were more ambiguous. Indeed there were more suffocated females in the control group: 6.36% vs 3.25% ($p < 0.001$), whereas there were more suffocated males in the HOA treated group: 1.36% vs 1.11% ($p < 0.05$). Treated animals had a lower H/L ratio: 0.81 vs 1.11 ($p < 0.01$) for males, 0.77 vs 0.85 ($p < 0.001$) for females. Corticosterone level was higher in the control group for males (3.40 vs 2.64, $p < 0.05$) but not for females ($p > 0.05$). The observed differences between the two groups suggest that chickens treated with HOA are subject to less stress than control chickens. Conversely, the number of suffocated animals is generally related to physiological distress, which tends to show that HOA has no real influence on this phenomenon. Economic data indicated that the gross margin was higher for the treated building by 4.8%. Further studies are required to more clearly define the physiologic and economic impact of treating chickens with HOA.

Key Words: Stress, Broilers, Apeasing

921 Involvement of anterior pituitary arginine vasopressin receptor V3 in the stress response of cattle. M. Knights^{*1}, N. K. Ames², and G. W. Smith², ¹*Division of Animal and Veterinary Sciences, West Virginia University, Morgantown,* ²*Departments of Large Animal Clinical Sciences, Michigan State University, East Lansing,* ³*Departments of Animal and Physiology, Michigan State University, East Lansing.*

The stress-induced increase in ACTH and cortisol is stimulated by corticotropin releasing factor (CRF) and arginine vasopressin (AVP). Effects of CRF and AVP are mediated via their anterior pituitary (AP) receptors, CRFR1 and V3 respectively. In the present studies, we evaluated effect of the V3 receptor antagonist deamino-AVP (dAVP) on LPS-induced ACTH and cortisol secretion and AP abundance of CRFR1 and V3 mRNAs in cattle. In Study 1, Holstein steers received i.v. saline or dAVP (10 μ g/kg), followed 1 h later by i.v. LPS (200 ng/kg) or saline ($n = 4$ per treatment). Previous studies demonstrated that dose of dAVP utilized effectively blocks AVP-induced ACTH and cortisol secretion in cattle. Blood samples were collected at time of LPS injection and 2 h later for determination of plasma ACTH and cortisol. ACTH and cortisol secretion were not affected by dAVP treatment alone. LPS increased ACTH secretion by 400% ($P < 0.001$) and the stimulatory effect of LPS was enhanced 200% by dAVP treatment ($P < 0.001$). A similar effect on cortisol secretion was observed, but the magnitude of increase was less. In Study 2, we determined effect of dAVP on LPS-induced changes in AP CRFR1 and V3 mRNA abundance. Intracerebroventricular (ICV) cannulated Holstein steers received either saline or ICV dAVP (750 μ g) followed 1 h later by i.v. saline or LPS. At 4 h post LPS, steers were sacrificed and AP collected for RNA isolation. Relative concentrations of AP CRFR1 and V3 mRNAs (normalized relative to RPL-19 mRNA) were determined using quantitative real-time PCR procedures. LPS decreased ($P < 0.05$) abundance of CRFR1 and V3 mRNAs compared to saline (control), but effects of LPS were blocked by ICV dAVP administration. Results lead to the suggestion that AP V3 receptor signaling pathways inhibit LPS-induced ACTH and cortisol secretion and LPS-induced down regulation of AP CRFR1 and V3 mRNAs in cattle. Supported by USDA 2001-35204-10801 (GWS) and the MI Agricultural Experiment Station.

Key Words: V3 Receptor, Stress, Cattle

922 Plasma progesterone response to ACTH administration in the ewe during diestrus and following ovariectomy. R. W. Godfrey^{*1}, A. J. Weis¹, R. E. Dodson¹, M. Loewer¹, and S. T. Willard², ¹*University of the Virgin Islands,* ²*Mississippi State University, Mississippi State.*

The role of the adrenal gland in reproduction has not been elucidated completely, yet has been suggested to be a significant source of progesterone (P4) in some species. The objective of this study was to evaluate the P4 response following ACTH administration in ewes synchronized to diestrus and in ewes following ovariectomy. Sixteen ewe lambs (27.0 \pm 0.82 kg; 8.1 \pm 0.04 mon of age) were synchronized using CIDRs, which were removed 12 d post-insertion. On d 11 post-CIDR withdrawal (diestrus), ewes received one of three treatments (i.v.): 1.0 IU ACTH ($n = 6$); 0.1 IU ACTH ($n = 5$); saline (control, no ACTH; $n = 5$).

Blood samples (plasma) were collected at Time -15, 0 (infusion), 15, 30, 45, 60, 120, 240 and 480 min in relation to ACTH treatment. Ewes were then ovariectomized (OVEX) 11 weeks later and ACTH challenges repeated. Plasma P4 and cortisol (CT) were determined by RIA. Plasma CT for diestrus ewes peaked at 30 min post-ACTH treatment for the 1.0 and 0.1 IU ACTH groups, increasing 5.5 \pm 0.8- and 2.6 \pm 0.7-fold over pre-treatment values. Plasma CT for OVEX ewes peaked at 60 min post-ACTH treatment for the 1.0 IU ACTH group and at 30 min for the 0.1 IU ACTH group; increasing 15.1 \pm 5.0- and 8.1 \pm 2.8-fold over pre-treatment values respectively. Area under the ACTH response curves (AUC; 0 to 120 min) for plasma CT differed ($P < 0.05$) among treatment groups in a dose-dependent fashion for diestrus and OVEX ewes. In diestrus ewes plasma P4 increased over time ($P < 0.05$) for all groups, and AUC for P4 differed ($P < 0.05$) between the 1.0 IU versus 0.1 IU and control treatment groups. In OVEX ewes, P4 AUC differed ($P < 0.05$) in a dose-dependent fashion, peaking at 60 and 30 min post-ACTH for the 1.0 and 0.1 IU ACTH groups respectively. In summary, ACTH administration in diestrus and OVEX ewes resulted in a dose-dependent increase in CT, as expected. In diestrus ewes only a transient increase in P4 was noted (1.0 IU ACTH group), while in OVEX ewes a dose-dependent effect of ACTH on adrenal P4 production was observed. These data indicate variable responses in adrenal P4 secretion post-ACTH administration in diestrus versus OVEX ewes.

Key Words: ACTH, Progesterone, Adrenal

923 Plasma progesterone response to ACTH administration in the pregnant ewe during early and late stages of gestation. S. T. Willard^{*1}, A. J. Weis², R. E. Dodson², M. Loewer², and R. W. Godfrey², ¹*Mississippi State University,* ²*University of the Virgin Islands.*

The adrenal gland has been suggested to contribute to the maintenance of pregnancy during times of acute stress through stimulation of adrenal progesterone (P4) production. However this has not been firmly established, nor has the secretion of P4 been characterized relative to stage of gestation in response to acute stimulation of adrenal function. The objective of this study was to evaluate the P4 response, above that of luteal/placental origin, following ACTH administration in ewes during early and late stages of gestation. Twenty pregnant St. Croix White ewes (49.7 \pm 2.0 kg; 4.0 \pm 0.4 yrs) were treated (i.v.) with one of the following: 1.0 IU ACTH ($n = 8$); 0.1 IU ACTH ($n = 6$); saline (control, no ACTH; $n = 6$) at 60 and 120 d of gestation. Blood samples (plasma) were collected at Time -15, 0 (infusion), 15, 30, 45, 60, 120, 240 and 480 min in relation to ACTH treatment. Plasma P4 and cortisol (CT) were determined by RIA. At 60 d of gestation, plasma CT peaked at 60 min post-ACTH treatment for the 1.0 IU ACTH group and at 30 min for the 0.1 IU ACTH group; increasing 13.0 \pm 6.1- and 6.3 \pm 1.3-fold over pre-treatment values. At 120 d of gestation, plasma CT peaked at 120 min post-ACTH treatment for the 1.0 IU ACTH group, and at 45-min for the 0.1 IU ACTH group; increasing 6.3 \pm 1.5 and 9.7 \pm 3.0-fold over pre-treatment values. Area under the ACTH response curves (AUC; 0 to 120 min) for plasma CT at 60 and 120 d of gestation differed ($P < 0.01$) among treatment groups in a dose-dependent fashion, while AUC for P4 did not differ ($P > 0.10$) among treatment groups. Plasma P4 increased over time ($P < 0.05$) throughout the day of challenge for all groups at 60 and 120 d of gestation, but did not differ ($P > 0.10$) relative to ACTH treatment. In summary for ewes during early and late gestation, ACTH administration resulted in a dose-dependent increase in CT, as expected. However, ACTH administration did not increase plasma P4 above that of pre-treatment baseline (luteal/placental) concentrations. These data indicate that ACTH administration does not result in a supplemental rise in adrenal P4 during early and late gestation in the pregnant ewe.

Key Words: ACTH, Progesterone, Gestation

924 Effects of temperament on stress indicators in Brahman heifers. K. O. Curley, Jr.^{*1,2}, D. A. Neuendorff², A. W. Lewis², J. J. Cleere², T. H. Welsh, Jr.¹, and R. D. Randel², ¹*Texas Agricultural Experiment Station, College Station,* ²*Texas Agricultural Experiment Station, Overton.*

The objective of this study was to compare adrenal responsiveness to pituitary stimulation with exogenous CRH in calm (C) and temperamental (T) heifers. The C and T groups (selected using exit velocity (EV) from a squeeze chute) consisted of the 6 slowest (EV=1.05 \pm .05 m/sec) and 6 fastest (EV=3.14 \pm 0.22 m/sec) 2-year old Brahman heifers in the herd.

Blood samples were collected via indwelling jugular cannulas (fitted ~18h prior) for a period of 6h pre- and 6h post- administration of CRH (0.1 µg/kg BW). Sampling intervals were 15min throughout the 12h except for the initial 30min and final 180min of the post-challenge period; where the sampling intervals were 5 and 30min, respectively. Serum cortisol (CS) concentrations were determined via RIA. Pearson correlation coefficients and ANOVA were used for statistical comparisons. Basal CS, determined as the mean concentration (ng/mL) within the 1h period prior to CRH challenge, was highly correlated to EV ($r=.90$; $P<.001$) and differed ($P<.001$) between temperament groups ($C=10.07\pm 2.3$ and $T=38.66\pm 3.7$). Following CRH challenge, both peak CS and time to reach peak CS did not differ between temperament groups. However, temperament did influence ($P=.01$) the increase, induced by the CRH challenge, from basal CS ($C=753\pm 220$ and $T=124\pm 47\%$). A negative correlation was found between EV and % increase in CS ($r=-.63$; $P<.03$). Time to return to basal CS was also influenced ($P<.04$) by temperament group as C took longer than T heifers ($C=267\pm 14$ and $T=152\pm 44$ min). The area under the curve following the return to basal CS was also influenced ($P<.01$) by temperament ($C=9222\pm 616$ and $T=14973\pm 1568$ ng*min/mL), indicating that the CS concentrations in the T heifers remained higher than C heifers. As poor temperament relates to increased basal adrenal activity and muted responsiveness to pituitary stimulus, temperament does affect stress mechanisms. Exit velocity can be used as an indicator of temperament and an indicator of pituitary-adrenal function.

Key Words: Temperament, CRH Challenge, Exit Velocity

925 Administration of exogenous prolactin (PRL) to steers on short day photoperiod: effects on PRL, PRL-receptor (PRL-R) expression, and immune function. T. L. Auchtung* and G. E. Dahl, *University of Illinois, Urbana.*

Photoperiod management significantly affects physiology of dairy cattle. For example, long day photoperiod (LDPP) during lactation increases milk yield, whereas short day photoperiod (SDPP) during the dry period increases milk production in the subsequent lactation. We have also observed an improvement in cellular immune function in animals on SDPP relative to their LDPP counterparts. In addition, PRL sensitivity is altered by photoperiod management. Our hypothesis is that the inverse relationship observed between PRL and PRL-R mRNA expression during photoperiod treatment alters the sensitivity of the animal to PRL, thereby affecting the changes in their cellular immune function. The objectives of this study were to supply exogenous PRL in vivo and in vitro models to determine the effects of PRL on photoperiod mediated immune responses. Eight Holstein steers received each of four treatments: LDPP (16 h light:8 h dark), SDPP (8 h light:16 h dark), SDom (SDPP plus PRL via osmotic minipump for 10 d), and SDinj (SDPP plus PRL via 3x daily injections for 10 d). Solutions of PRL were formulated so that animals received 4.0 mg/d PRL with 0.9% saline. Steers on SDPP had decreased PRL concentrations ($P < 0.05$) relative to the other three treatments. Expression of long form PRL-R mRNA on lymphocytes was increased in SDPP treated animals relative to LDPP, SDom, and SDinj. Prior to PRL treatment, SDPP animals had greater lymphocyte proliferation and neutrophil chemotaxis ($P < 0.01$) relative to LDPP animals. However, following PRL treatment, lymphocyte proliferation and neutrophil chemotaxis of SDom and SDinj animals were reduced to the level of LDPP animals. Addition of PRL to the in vitro lymphocyte proliferation increased proliferation of lymphocytes from SDPP animals but did not alter response of LDPP animals. These results support the concept that an animal's altered PRL sensitivity mediates the changes in cellular immune function observed with photoperiod manipulation.

Key Words: Prolactin, Photoperiod, Immune Function

926 Characterization of changes in hepatic expression of inflammation-associated genes during the periparturient period in multiparous Holstein cows using quantitative real time-PCR (RT-PCR). N. A. Janovick*, J. J. Loor, H. M. Dann, H. A. Lewin, and J. K. Drackley, *University of Illinois, Urbana.*

Dietary strategies in the dry period and early lactation might impact hepatic expression of genes associated with inflammatory responses, which in turn could impact metabolic adaptations to lactation. The objective of this study was to characterize changes in hepatic expression

of tumor necrosis factor- α (TNF- α), peroxisome proliferator activated receptor- γ (PPAR- γ), PPAR- α , and interleukin-6 (IL-6) during the dry period through 49 DIM in cows fed according to current NRC recommendations. Five multiparous Holstein cows had ad libitum access to a far-off dry period diet (1.29 Mcal NE₁/kg; 15.8% CP) from d -65 through -25 relative to parturition, followed by ad libitum access to a close-up diet (1.61 Mcal NE₁/kg; 15.7% CP) from d -24 until parturition. Cows were fed a common lactation diet (1.77 Mcal NE₁/kg; 18.1% CP) from 1 through 49 DIM. Liver biopsies were collected on d -65, -30, -14, +1, +14, +28, and +49 relative to calving and RNA was extracted with Trizol reagent. Complementary DNA was made from 2 µg of total RNA and primers for RT-PCR were designed to yield amplicons #8804100 bp. Relative copy number in PCR amplifications was measured using SYBRGreen I Dye fluorescence. Bovine 18S rRNA was used as an internal standard for data normalization. Day -65 relative to parturition was used as a baseline to compare relative changes in expression. Relative to d -65, preliminary analysis of data using all cows showed that relative copy number of TNF- α was 1.85-fold greater ($P = .05$) on d +1 relative to calving. Fold changes on d -14 and +14 were 1.11 and 1.57 compared to d -65 ($P > .17$). Relative to d -65, fold changes in relative copy number of PPAR- γ were 1.36, 1.94, or 1.83 on d -14, +1, and +14, respectively ($P > .36$). Results showing increases in relative copy number for these two genes suggest that inflammatory or general stress responses occurred in the liver after parturition.

Key Words: Real Time-PCR, Hepatic Genes, Periparturient Period

927 Effect of estrus and pregnancy status on growth hormone receptor and IGF-I gene expression in the uterus and liver of postpartum dairy cows. M. L. Rhoads*, J. P. Meyer, W. R. Lamberson, D. H. Keisler, and M. C. Lucy, *University of Missouri, Columbia.*

Growth hormone (GH), the GH receptor (GHR) and IGF-I are thought to play critical roles during early pregnancy in dairy cattle. The objective of this study was to measure total GHR (tGHR) and IGF-I mRNA in liver and uterine (endometrial) tissue around the time of artificial insemination at four stages of lactation (1=46 ± 4 d, n=5; 2=80 ± 3 d, n=11; 3=122 ± 3 d, n=10; 4=160 ± 3 d, n=8). Estrus was synchronized with PGF_{2α} and cows were inseminated 12 h after estrus. Uterine biopsies were collected at the PGF_{2α} injection (before estrus, BE), at the initiation of estrus (E) and 4 d after estrus (AE). Liver was biopsied AE. The amount of tGHR and IGF-I mRNA in liver and uterus was analyzed by real-time quantitative PCR. tGHR mRNA and IGF-I mRNA were correlated in liver ($r=0.64$, $P<0.01$) and uterus ($r=0.85$, $P<0.01$) but neither mRNA were affected by stage of lactation. The amount of liver IGF-I mRNA ($r=0.67$, $P<0.01$) but not uterine IGF-I mRNA ($P>0.10$) was positively correlated with plasma IGF-I concentrations. The conception rates for stages 1, 2, 3 and 4 were 80, 55, 50 and 25%, respectively. There was an effect of pregnancy status on liver tGHR mRNA because cows that became pregnant had more tGHR mRNA than non-pregnant cows (41.8 ± 3.2 and 27.4 ± 3.8 AU, respectively; $P<0.01$). There was no effect of pregnancy status or stage on uterine tGHR or IGF-I mRNA. There was an effect of day of the estrous cycle because uterine tGHR mRNA (eight-fold increase over BE; $P<0.05$), uterine IGF-I mRNA (five-fold increase over BE; $P<0.01$) and plasma IGF-I were highest at estrus. In summary, uterine IGF-I gene expression was correlated with tGHR mRNA. Both tGHR and IGF-I mRNA increased in uterine tissue at estrus, a time when blood IGF-I concentrations were also greatest. Cows that became pregnant had similar uterine mRNA but higher liver tGHR mRNA. These data fail to implicate uterine mRNA in the establishment of pregnancy but instead suggest that liver tGHR is greater in early pregnancy.

Key Words: Growth Hormone Receptor, IGF-I, Uterus

928 Assessments of udder temperature gradients pre- and post-milking relative to milk production in Holstein cows as determined by digital infrared thermography. S. Schmidt*, S. Bowers, T. Dickerson, K. Graves, and S. Willard, *Mississippi State University, Mississippi State.*

Digital infrared thermal imaging (DITI) is a non-invasive diagnostic technique that can be used to measure symmetry and/or asymmetry of surface temperature gradients associated with physiological phenomenon. In the present study, thermal images were acquired from lactating Holstein cows ($n = 16$) to assess temperature gradients of the

mammary gland in high (n = 8; 18.5 ± 1.5 kg milk, 182.9 ± 6.75 DIM) and low (n = 8; 14.9 ± 1.3 kg milk, 182.8 ± 6.7 DIM) milk producers (MP). Three thermal images (left-fore, right-fore and rear udder) were acquired for each cow pre- and post-milking at bimonthly intervals over a period of 3 months (6 measurement periods). Rectangular transects were drawn on thermal images to quantify temperature gradients of the udder, and temperatures (°C) were expressed as MAX, AVG, MIN and standard deviation (SD) within transect areas. Udder volume (UV) measurements were collected at the time of imaging pre- and post-milking. No differences (P > 0.10) were observed in UV for high versus low MP throughout the study. Overall, MAX and AVG udder and teat temperatures were greater (P < 0.001) pre-milking than post-milking, as were MIN teat temperatures (P < 0.01). Udder temperatures also differed (P < 0.01) by udder quarter pre- and post-milking, while teat temperatures by quarter did not differ (P > 0.10) pre- or post-milking. High MP had greater (P < 0.01) udder temperatures than low MP (MAX, AVG, MIN) pre- and post-milking (AVG: High Pre, 34.8 ± 0.07 °C; High Post 34.6 ± 0.08 °C; Low Pre: 34.07 ± 0.09 °C, Low Post 33.7 ± 0.09 °C), while teat temperatures did not differ (P > 0.10) relative to level of milk production. Temperature SD within transect areas did not differ (P > 0.10) pre- or post-milking for udder quarter or teat, indicating uniformity of temperature measurements within transects. In summary, high MP had greater udder temperatures pre- and post-milking than low MP. These data suggest that DITI may have value as a diagnostic tool for assessing udder function in relation to temperature gradient changes and level of milk production.

Key Words: Udder, Thermography, Milk Production

929 Heat dissipation in winter-acclimated lactating cows and non-lactating heifers subjected to increased ambient temperature and solar radiation in Arizona. B. C. Pollard*, E. A. Annen, L. H. Baumgard, R. C. Cheatham, M. D. Es-theimer, M. E. Dwyer, A. C. Fitzgerald, H. C. Halfliger, C. E. Moore, J. K. Kay, O. B. Mendivil, P. C. Gentry, D. A. Henderson, C. M. Steining, and R. J. Collier, *The University of Arizona, Tucson.*

Heat dissipation responses of dairy cattle to heat stress are poorly understood. The objective of this study was to compare total evaporative water loss (TEWL) in winter-acclimated lactating cows vs. non-lactating heifers, under three environmental conditions. Six lactating cows (DIM 60-110) and six pregnant, non-lactating heifers (150 d pregnant) were assigned randomly to bST (Posilac®, Monsanto Co., St. Louis, MO) or no bST. Beginning January 21, 2004, animals were housed in two environmental rooms (n=6/room) with temperature, solar radiation, humidity and day length (18 h light:6 h dark) control. The study was divided into two phases of 14 d each. In phase 1, room 1 was held at thermoneutral (TN; temp. range=8.4-17.0°C) while room 2 was programmed to provide heat stress (HS; temp. range=27.8-38.9°C). In phase 2, cows in room 1 were treated to HS plus 4 h of solar radiation (HS+S; 600 Wh/m²) while room 2 remained at TN conditions. After 1 wk, heat dissipation was determined by TEWL from the loin and rump of both left and right sides (Vapometer®, Delfin Technologies, Finland). Overall, TEWL was greater (P < 0.05) in cows vs. heifers in all environmental conditions. Average TEWL was increased in HS and HS+S over TN (P < 0.001), and TEWL was higher in lactating cows compared heifers in HS and HS+S (P < 0.001). These results demonstrate that cows increase their insensible heat dissipation in order to cope with the increased heat load from both milk production and increased environmental heat stress.

Key Words: Heat Stress, Dairy Cattle, Solar Radiation

930 Hepatic gene expression profiling in lactating dairy cows during an initial period of hyperthermia. R. P. Rhoads*¹, J. D. Sampson¹, R. J. Tempelman², S. S. Sipkovsky², P. M. Coussens², M. C. Lucy¹, J. N. Spain¹, and D. E. Spiers¹, ¹University of Missouri, Columbia, ²Michigan State University, East Lansing.

Environmentally-induced hyperthermia in lactating dairy cows depresses milk production as a consequence of whole body adaptations involving

shifts in metabolism and a reduction in feed intake. In this context, the liver is uniquely positioned to direct exogenously and endogenously-derived nutrients for use by other metabolically active tissues such as the mammary gland. Despite the prominent role of the liver in whole-body metabolism, changes in the molecular mechanisms leading to hepatic adaptation during heat challenge are unclear in the dairy cow. Therefore, the objective of this study was to characterize the gene expression profile of hepatic tissue in dairy cows undergoing a transition from thermoneutral (TN) to heat stress (HS) conditions. Six Holstein dairy cows (61 ± 8 d postpartum) were acclimated to TN conditions (19° C) for 1 wk prior to exposure to HS conditions (29° C). Rectal temperature (Tre) and respiration rate (RR) were measured at 4 h intervals during both periods. Total RNA from liver biopsies obtained on d 4 of the TN period (n=6) and then at 24 (n=2), 48 (n=2) and 96 (n=2) h of the HS challenge was reverse transcribed to cDNA. TN and HS paired samples were sequentially labeled with Cy3 or Cy5 prior to hybridization to a bovine-specific NBFGC microarray containing 18,263 unique ESTs. Reversal of the dye direction between paired samples was used to account for possible dye bias. Gene expression data were normalized and analyzed using a two-stage mixed effects model in SAS. The transition from TN to HS increased Tre (39.0° vs 40.3° C, P<0.01) and RR (62 vs 86 breaths per minute, P<0.01). Preliminary analysis indicates that hyperthermia induced the differential expression of at least 20 genes (P<0.001) with a similar number of up and down-regulated genes. In conclusion, the imposed heat stress was sufficient to alter liver gene expression that may be important in the hepatic adaptation to heat challenge.

Key Words: Liver, Microarray, Hyperthermia

931 Exposure to endotoxin during estrus or corpus luteum formation impaired reproductive functions in cows. Y. Lavon¹, G. Leitner², T. Goshen¹, M. Hogeg¹, R. Braw-Tal³, M. Maman¹, S. Jacoby³, and D. Wolfenson*¹, ¹The Hebrew University, Rehovot, Israel, ²The Veterinary Institute, Bet Dagan, Israel, ³Agricultural Research Organization, Bet Dagan, Israel.

Effects of endotoxin (LPS) during estrus (E) or CL formation were studied in lactating Holstein cows. In Exp. 1, synchronized cows were watched continuously for estrous behavior. LPS was given iv (500 ng/kg) or intra-mammary (imm, 10 ug/cow), 16 h prior to expected onset of E (iv, n=4; imm, n=4), and at onset of standing E (iv, n=13; imm, n=8). Time of ovulation (OV) was determined by ultrasound during 4 days (d). LPS typically induced hyperthermia and increased plasma cortisol (ANOVA, P<0.05). Five cows receiving LPS prior to E (iv and imm) responded abnormally: two neither showed E nor ovulated during 4 d; three that showed E 36 h later than normal, then ovulated after a normal interval (within 30 h). Four cows (31%) receiving LPS iv at E onset responded abnormally: one did not ovulate during 4 d, three shortened their E behavior, showed additional E 60 h later, then ovulated within 30 h. 3 cows (38%) receiving LPS imm at E onset responded abnormally: one did not ovulate during 4 d, two showed normal E but a delayed OV. A delayed OV was associated with a delayed progesterone concentration rise (P<0.05). Collectively, 34% of cows responded abnormally after LPS at E (iv or imm, P<0.05). Control cows (n=12) showed normal E and a normal interval to OV. In Exp. 2, cows were given a single imm LPS dose on d 3 (n=5) or d 5 (n=5) of the cycle. The general pattern of follicular dynamics and progesterone concentrations were not affected by LPS treatment. However, the cycle was extended in 5 of 10 cows (50%) treated with LPS on d3 or d5: three did not show E and did not ovulate by 30 d after the previous E; two had extended cycle (27 d). Of the control cows (n=4), only one had an extended cycle (28 d), three had normal length cycles (22.6 d). Results show that exposure to endotoxin around E delays E and/or time to OV in about one-third of cows; a similar proportion of cows exposed to LPS at time of CL formation exhibited an extended cycle length.

Key Words: Endotoxin, Estrus, Dairy Cows

932 Estimation of energy value of feed and its use in ration formulation. H. F. Tyrrell*, *Cooperative State Research, Education & Extension Service, USDA, Washington, DC.*

Estimation of the energy value of a ration is fundamental for the determination of the quantity required to meet the energy requirement of the animal. Net Energy is the best estimate of the energy value of a feed/ration, but is difficult, time consuming and costly to determine. In addition, it is virtually impossible to measure the energy value of a single feedstuff fed to a representative animal because few, if any, feedstuffs contain the appropriate balance of nutrients required by the target animal. In practice, estimated net energy value of individual feedstuffs used in ration formulation have been derived from equations relating net energy to some more easily determined characteristic of a feedstuff, typically some measure of digestibility such as Total Digestible Nutrients (TDN). This method is reasonably accurate as long as the TDN value used is appropriate for the target animal. For example, it is well established that the TDN value of a ration fed to a lactating dairy cow at a daily intake required to support lactation is significantly lower than the TDN value of the same ration fed to the same cow at a maintenance level of intake when the cow is not lactating. Level of intake is only one of several factors which can depress the TDN value of a ration fed at production levels of intake. Protein quantity/quality which is adequate to support maximal digestibility in an animal at maintenance may significantly depress TDN value when protein is limiting for lactation. TDN measured using sheep may be appropriate for the estimation of the energy value of feedstuffs for cattle where appropriate equations are available. Variation in digestibility of feed is the main source of variation in energy value of feed.

Key Words: Net Energy, Digestibility, TDN

933 Feed efficiency is driven by dry matter digestibility. D. P. Casper*, L. Whitlock, D. Schauff, D. Jones, D. Spangler, and G. Ayangbile, *Agri-King, Inc., Fulton, IL.*

The improvement in Feed Efficiency (FE; Milk/Dry Matter Intake) by dairy cows can have a dramatic impact on the profitability of the dairy operation. This study was conducted to evaluate the range in FE across several farms and to determine what factors may affect FE. Total mixed rations (TMR) and fecal samples were collected from six dairy farms that were feeding a total mixed ration, along with measurements of milk production, milk composition, and dry matter intake (DMI). The forages fed on these farms consisted of haylage, corn silage, balage, and dry hay. Total mixed rations and fecal samples collected at the same time were analyzed for standard nutrients. Acid insoluble acid was used as an internal marker to calculate nutrient digestibility coefficients. Twenty-three observations were collected over a period of several months. Milk production averaged 30.8 kg/d and ranged from 21.4 to 36.6 kg/d across the study. Milk fat percentage averaged 3.78% and ranged from 3.43 to 4.10%. 3.5% fat-corrected milk averaged 32.0 and ranged from 27.8 to 35.3 kg/d. Dry matter intake averaged 21.2 kg/d and ranged from 16.3 to 25.9 kg/d. Feed efficiency (Milk/DMI) averaged 1.47 and ranged from 1.23 to 1.85. Dry matter digestibility averaged 70.5% and ranged from 57.7 to 84.6%. Regression analysis demonstrated that the dry matter digestibility of the ration fed to lactating dairy cows was the most significant predictor of FE ($FE = 0.032 + 0.02 * DMD$; $R^2 = 0.59$, $P < 0.01$). This study also demonstrated that as FE increased the DMI by the cows decreased ($FE = 2.76 - 0.062 * DMI$, kg/d; $R^2 = 0.72$, $P < 0.01$). The dry matter digestibility of the ration is the major factor affecting the FE by lactating dairy cows. The biggest factor affecting ration dry matter digestibility is forage quality and the digestibility of that forage.

Key Words: Feed Efficiency, Digestibility, Forage Quality

934 Predicting feed passage rate in dairy cattle. S. Seo*, L. Tedeschi¹, C. Schwab², and D. G. Fox¹, ¹*Cornell University, Ithaca, NY*, ²*University of New Hampshire, Durham.*

The database used to develop the passage rate (kp) equations of the 2001 Dairy NRC was used to perform a sensitivity analysis on the variables used to derive the equations and to investigate the sensitivity of MP supply and allowable milk production using a Monte Carlo technique. Three equations were developed by the 2001 Dairy NRC to predict kp

for dry forage, wet forage, and concentrate using a meta-analysis technique (trial as a random effect). The database was comprised of studies that used rare earth markers. Outliers were identified by acceptance criteria defined a priori or the difference in fit statistic (DFFITS) value. We found the sign of the regression coefficient of ConcpDM in the equation for kp dry forage in 2001 Dairy NRC was inverted; it should be positive: $kp \text{ dry forage} = 3.362 + 0.479 \text{ DMIPBW} - 0.017 \text{ NDF} + 0.007 \text{ ConcpDM}$ ($n=319$), where kp is passage rate, %/h; DMIPBW is DMI as % of BW; NDF is NDF content of the forage, %DM; and ConcpDM = Concentrate content as % of dietary DM. The sensitivity analysis indicated that kp predictions were more sensitive to the variation in DMI than to any other variable. Additionally, based on the 90% confidence interval, a variation in a change in MP supply and MP allowable milk of 188 g and 4 kg, respectively. The kp for concentrate had the highest standardized regression coefficient (0.906) compared to kp for dry forage (0.092) and wet forage (0.019) in the prediction of MP allowable milk from supply of MP. The variation in RDP, RUP, and MP supply were mainly caused by the variations in kd, CP, and kp values of concentrates in the simulation. Accuracy was improved when new kp equations were developed using the entire database (1,271 treatment means). The new equations were: $kp \text{ dry forage} = 2.819 + 0.684 \text{ DMIPBW} - 0.015 \text{ NDF} + 0.003 \text{ ConcpDM}$ ($n=399$); $kp \text{ wet forage} = 2.384 + 0.854 \text{ DMIPBW} - 0.012 \text{ ConcpDM}$ ($n=74$); and $kp \text{ concentrate} = 3.374 + 1.123 \text{ DMIPBW} - 0.016 \text{ ConcpDM}$ ($n=264$). We conclude these empirical equations are suitable for predicting passage rate. However, the development of a more mechanistic model that accounts for more of the biologically important variables affecting passage rate is needed.

Key Words: Passage Rate, Sensitivity Analysis, Dairy Cattle

935 Effect of peNDF and starch source on digestibility and ruminal pH and turnover in dairy cows. P. Berzaghi*¹ and D. R. Mertens², ¹*University of Padova, Italy*, ²*ARS-US Dairy Forage Research Center, Madison, WI.*

The effects of ration physically effective NDF (peNDF) and starch source on ruminal characteristics and digestibility were investigated. A negative control (NC) diet was formulated to induce milk fat depression, which contained 19% peNDF using finely chopped (TLC = 6.4 mm) corn silage as the main fiber source. Three diets were formulated to increase peNDF to 22% by adding about 9.5% finely chopped corn silage (CS), 12.2% chopped alfalfa hay (AH), or 6.7% chopped grass hay (GH) to NC. Diets for the four fiber sources were formulated with dry ground corn (DGC) or finely ground high moisture corn (HMC) to obtain eight diets that varied in starch source and peNDF source and concentration. Twenty-four cows were blocked for milk production and half were assigned to either DGC or HMC diets in replicated 4x4 Latin squares with 21d periods. One Latin square for starch source contained ruminally fistulated cows. In the cannulated cows ruminal pH was measured for one day every three hours and rumen contents were manually evacuated before and after feeding and separated into solids and liquids. Fecal samples were obtained during the last week of each period. Indigestible NDF of feeds, ruminal contents and feces was determined by 240-h in situ incubation in all cows in the period following their collections. Mixed-model ANOVA indicated that NC and CS had lower ($P < 0.05$) ruminal pH at 3-h post feeding, but similar average (24 h) ruminal pH across diets. Rumen pool of DM and indigestible NDF (INDF) was not affected ($P > 0.05$) by diet and starch source. However, turnover rate of INDF was increased ($P < 0.05$) by the addition of AH and GH to the NC diet. Apparent DM digestibility (DMD) was not affected by starch source, but was highest for NC diet and lowest ($P < 0.01$) in AH and GH. A positive relationship ($r^2 = 0.54$; $P < 0.01$) between retention time and DMD partially explained the differences in digestibility. In conclusion, dietary peNDF altered ruminal pH and affected DMD possibly by changes in retention time and associative effects

Key Words: Physically Effective Fiber, Digestibility, Ruminal pH

936 In situ estimation of dry matter digestibility and degradable intake protein to evaluate the effects of corn processing method and length of ensiling. J. R. Benton*, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

Three ruminally cannulated steers were used to evaluate the effects of corn processing method and length of ensiling on dry matter digestibility (ISDMD) and degradable intake protein (DIP). Corn processing consisted of dry-rolled (DRC), high-moisture at 24% (24HMC) or 30% (30HMC) moisture, and reconstituted corn at 28% (28RECON) or 35% (35RECON) moisture, all of the same hybrid. All corn (except DRC) was ensiled for at least 298 d, and sampled every 28 d. Corn samples were incubated in situ for 0, 22, 30, and 72 h and ISDMD (%) and DIP (% of CP) were calculated. Values (22 h) were regressed over ensiling days. The intercept represents changes in ISDMD or DIP during the first 28 d of ensiling where the greatest changes occurred, with the greatest increase for 35RECON followed by 30HMC and then 28RECON. The slope represents changes in ISDMD or DIP over time of ensiling after 28 d. The slopes of reconstituted corn (RECON) were greater than high-moisture corn (HMC) because RECON had a greater increase in total ISDMD and DIP compared to HMC. The slope of 24HMC was not different from 30HMC for ISDMD, while the slope of 24HMC was greater than 30HMC for DIP. The slope of 28RECON was greater than 35RECON for ISDMD and DIP. When moisture was increased for HMC (from 24 to 30%) and RECON (from 28 to 35%), total ISDMD and DIP increased, and both HMC and RECON had increased total ISDMD and DIP compared to DRC. Results suggest that as moisture and length of fermentation increase, ISDMD and DIP are increased.

Corn	ISDMD		Slope ^{ab}	DIP		Slope ^{ab}
	day 0	(%) Intercept ^a		day 0	(% of CP) Intercept ^a	
24HMC	38.0	37.7 ^c (1.2)	0.44 ^c (0.06)	45.1	41.6 ^c (0.9)	0.51 ^c (0.05)
30HMC	45.4	61.3 ^d (1.0)	0.38 ^c (0.06)	48.8	68.1 ^d (0.8)	0.40 ^d (0.05)
28RECON	29.0	46.3 ^e (1.0)	1.21 ^d (0.05)	34.3	47.1 ^e (0.7)	1.38 ^e (0.04)
35RECON	29.0	68.8 ^f (1.0)	0.70 ^e (0.06)	34.3	64.9 ^f (0.7)	0.95 ^f (0.05)
DRC	29.0	—	—	34.3	—	—

^aValues in parenthesis are standard errors

^bPredicted ISDMD or DIP=Intercept+Slope(10 days of ensiling)

^{cdef}Slopes within a column with different superscripts differ (P<0.10)

Key Words: Grain Processing, In Situ, Protein Digestion

937 Effects of nonfiber carbohydrate source and protein degradability on ruminal protein fractions and NDF disappearance. M. B. Hall* and C. C. Larson, *Department of Animal Sciences, University of Florida, Gainesville.*

Effects of nonfiber carbohydrate source (NFC) and protein degradability (RUP) on concentrations (mM) of ammonia (NH₃), amino acid (AA), and branch chain VFA (BCVFA) in ruminal fluid, and on in situ disappearance of NDF from sorghum silage were evaluated using 6 ruminally cannulated Holstein cows in a three period (21 d) partially balanced incomplete latin square design with a 3x2 factorial arrangement of treatments. Dietary treatments included three NFC sources (ground corn=starch=ST; molasses+sucrose=sugar=SU; and citrus pulp=soluble fiber+sugar=SF) and two concentrations of ruminally degradable protein (+or-RUP) achieved by addition or omission of expeller soybean meal. Total mixed rations were formulated to be isonitrogenous and offered ad libitum. Sorghum silage (2 mm Wiley mill grind) was incubated in situ in polyester bags (53 ± 10 μm pore size) inserted via the rumen cannula on days 16, 17, and 18 at intervals to allow incubation times of 0, 6, 12, 18, 24, 30, and 48 h; residual NDF was measured. Ruminal fluid samples were collected on day 20 just prior to feeding and hourly for 12 h. Protocols were applied in each period. Significance was declared at P#88040.05; values presented are least squares means. NH₃ differed only for RUP x hr in hours 1 through 3 post-feeding, with -RUP greater than +RUP. AA differed by NFC in hr 1 through 3, with ST less than SU + SF, and for interactions of NFC x hr and RUP x hr for all hours. BCVFA differed by NFC source with ST greater than SU+SF, and SF tended to be greater than SU (P=0.07). BCVFA tended to differ by RUP x hr (P=0.10). In situ disappearance of NDF differed for NFC and NFC x RUP in hours 6, 18, 24, and 30, and tended to differ for NFC x RUP at 48 h (P=0.054). Differences did not appear to be solely due to ruminal pH. Differences in ruminal AA and BCVFA suggest that ruminal protein digestion or use differs by

NFC source. Differences in in situ disappearance of NDF suggest that in situ results are not likely to be uniform across diets and may be best suited for relative evaluation of NDF digestibility.

Item	ST-RUP	ST+RUP	SF-RUP	SF+RUP	SU-RUP	SU+RUP
NH ₃	12.3	10.8	12.1	9.6	11.8	10.1
AA	1.64	1.46	1.86	1.73	1.94	1.76
BCVFA	3.79	3.48	3.31	2.87	2.45	2.26
pH	5.99	5.98	6.11	6.03	5.83	6.07
24 h IS	19	26	21	20	16	21
30 h IS	26	32	32	26	22	27
48 h IS	39	42	43	40	39	39

NH₃ for sampling hours 1 through 3; AA, BCVFA, and pH for sampling hours 0 through 12.

IS = percentage of in situ NDF disappearance.

Key Words: NFC, Fermentation, Carbohydrate

938 Effect of starch source on supply of glycogenic nutrients in dairy cows. A. M. van Vuuren*, V. A. Hindle, and J. W. Cone, *Animal Sciences Group, Wageningen UR, The Netherlands.*

In ruminants, propionic acid and glucose are the main glycogenic precursors. Thus, the supply of glycogenic precursors from starch is related to its site of digestion. In this study the site of digestion of starch from wheat, corn, and potato was estimated in dairy cows. A Latin square design experiment was performed involving four lactating dairy cows each fitted with a rumen cannula and T-piece cannula in the distal duodenum and terminal ileum. Each cow received either a starch-free diet, containing 43 %DM grass silage, 11 %DM ensiled sugar beet pulp and 46 %DM of a starch free concentrate mixture with 70 % dried sugar beet pulp (DSBP) or diets in which DSBP had been replaced by either wheat (WS), corn (CS) or potato (PS) starch. Diets were fed during periods of four weeks, faecal and digesta collections were performed in the third and fourth week of each period, respectively. The glycogenic nutrient supply for each diet was estimated on the basis of the amounts of OM digested in rumen and large intestine, patterns of VFA concentrations in the rumen and the amount of starch digested in the small intestine. Significance was declared at P<0.05. Starch intake was 0.31^c, 3.47^b, 3.90^a, and 3.69^{ab} kg/day for control diet, and diets with WS, CS and PS, respectively. The rumen was the main site of digestion for starches from all origins and was estimated at 90^a, 75^b, and 84^a % of intake of WS, CS and PS, respectively. In the small intestine, 70% of rumen escaped WS was digested compared to 65% for CS, but this difference was not significant. We observed no disappearance of PS in the small intestine. Almost all starch entering the large intestine was digested, resulting in a faecal starch output of less than 0.10 kg/d. Concentrations of ruminal VFA were similar amongst treatments. The proportion of propionate in rumen fluid differed significantly between the WS diet (21 mol%) and the PS diet (18 mol%). The highest supply of glycogenic nutrients was calculated for the CS diet (0.8 moles per kg ingested OM). According to our calculations, the PS diet yielded the lowest supply of glycogenic nutrients (0.6 mol per kg ingested OM).

Key Words: Dairy Cattle, Starch, Digestion

939 Microbial profiling of ruminal and omasal samples from cows fed different sources of methionine. S. K. R. Karnati*, J. T. Sylvester, Z. Yu, S. M. Noftsker, N. R. St-Pierre, M. Morrison, and J. L. Firkins, *The Ohio State University, Columbus.*

Supplemental methionine improves milk protein yield with diets low in CP either through stimulation of microbial CP synthesis or through escape of methionine. Previous work suggested that HMB (2-hydroxy-4-methylthiobutanoic acid) might promote changes in ruminal bacterial or protozoal populations. DGGE (denaturing gradient gel electrophoresis) and RIS-LP (ribosomal intergenic spacer length polymorphism) were used to monitor treatment-induced changes in microbial populations in the rumen and omasum of cattle fed control, HMB, dl-methionine, or HMBi (isopropyl ester HMB; estimated 50% rumen protection) in a 4 x 4 Latin square design. For DGGE, a hypervariable region of the 18S rRNA gene was amplified from the extracted DNA using PCR with a ciliate-specific primer set. Amplicons were separated on an 8% acrylamide gel with a 28-36% denaturing gradient. The banding patterns

were similar for both ruminal and omasal samples and were not different among treatments. Protozoal counts were not different among treatments ($P > 0.05$) in ruminal or omasal samples. Generic protozoal counts were not different ($P > 0.05$) among treatments, corresponding with similar banding profiles from DGGE. Multivariate statistics showed no difference ($P > 0.05$) in generic distribution of protozoa in ruminal vs. omasal samples, supporting absence of selective retention of Isotrichs in the rumen. Extracted DNA from omasal contents was amplified in PCR using S926f and L189r primers for RIS-LP analysis. Amplicons containing the complete RIS and parts of the flanking rRNA genes were separated on a 4% polyacrylamide gel. The RIS-LP gel image was exported into image analysis software. Cluster analysis of banding profiles grouped the treatments together, suggesting that bacterial populations differed among treatments. Source of methionine appeared to change ruminal bacterial but not protozoal populations. Future research will characterize bacterial populations altered by HMB supplementation.

Key Words: DGGE of Ruminal Protozoa, RIS Analysis, HMB

940 Effects of different components of garlic oil on rumen microbial fermentation in a continuous culture system. Marta Busquet¹, Sergio Calsamiglia^{*1}, Alfred Ferret¹, and Christopher Kamel², ¹Universitat Autònoma de Barcelona, Spain, ²University of Leeds, UK.

Preliminary in vitro batch culture trials using garlic oil (G) and 4 of its constituents (diallyl sulphide = Ds; diallyl disulphide = Dd; allyl mercaptan = Am; and allicin = A) indicated that only the doses of 30 and 300 mg/L of G, Dd, and Am modified rumen microbial fermentation profile. Eight 1.3-L dual flow continuous culture fermenters were used in three periods (8 d) to study the effects of these extracts on rumen microbial fermentation profile in a long-term in vitro study. Fermenters were fed 95 g/d of the 50 to 50 forage to concentrate diet. Treatments were: no extract or negative control (C), G (300 mg/L = G10) Dd (30mg/L = Dd, 300mg/L = Dd10) and Am (30mg/L = Am; 300mg/L = Am10). 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 3 days, samples were taken at 0, 2, 4 and 6 h after the morning feeding, and analyzed for peptide (Pep), aminoacid (AA) and NH₃ N concentrations. Total VFA were similar across treatments (122.2 mM). Acetate proportion (mol/100mol) was lower in G10 (48.0), Dd (53.5), Dd10 (49.2), and Am10 (51.0) compared with C (60.7). Propionate proportion (mol/100mol) was higher in G10 (30.5) compared with C (21.8). Butyrate proportion (mol/100mol) was higher in Dd10 (20.3) compared with C (12.4). Average Pep-N concentration (mg/100ml) was similar in all treatments. Average AA-N concentration (mg/100ml) tended to increase ($P = 0.07$) in Dd10 (4.6) compared with C (2.9), and the average NH₃ N concentration (mg/100ml) tended to increase ($P = 0.08$) in Am10 (15.4) compared with C (10.5), suggesting that Am10 stimulated deamination. All garlic oil components resulted in similar effects to those observed in G10. However, G10 had stronger effects (and similar to ionophore antibiotics) which could be explained by a synergistic activity between its constituents.

Key Words: Rumen Fermentation, Plant Extracts, Garlic

941 Effects of *Lactobacillus acidophilus* and *Propionibacterium freudenreichii* on performance and rumen characteristics of Holstein dairy cows in mid-lactation. M. L. Raeth-Knight* and J. G. Linn, University of Minnesota, St. Paul.

A lactation study (Study 1) was conducted from February 12, 2003 to May 6, 2003. Thirty-nine multiparous and eighteen primiparous Holstein cows were blocked by parity and randomly assigned to one of three

dietary treatments; remaining on treatment for 84 days. Treatments included: 1 x 10⁹ cfu/day live *Lactobacillus acidophilus* strain LA747 and 2 x 10⁹ cfu/day live *Propionibacterium freudenreichii* strain PF24 (Diet A), 1 x 10⁹ cfu/day live *Lactobacillus acidophilus* strain LA747, 2 x 10⁹ cfu/day live *Propionibacterium freudenreichii* strain PF24, and 5 x 10⁸ cfu/day *Lactobacillus acidophilus* strain LA45 (Diet B) and lactose (Control- Diet C). Treatments were administered by mixing 45 grams of finely ground corn with 5 grams of live microbial product or lactose and top dressing on the TMR once daily. All cows received the same TMR: 12.7% hay, 46.2% corn silage and 41.1% concentrate (DM basis). A Latin square study (Study 2) was conducted concurrently with the lactation study. Three rumen cannulated, multiparous Holstein cows were randomly assigned to dietary treatments A, B, and C in a 3 x 3 Latin square design with 28 day periods; 21 days of adaptation and 7 days of data collection. In Study 1, there was no difference ($P > .1$) in average DM intake (23.90, 23.60 and 24.19 kg/d) or 4% FCM (36.68, 35.18 and 36.12 kg/d) for treatments A, B, and C, respectively. There was no difference ($P > .1$) in fat, protein or lactose yield, milk urea nitrogen or somatic cell count. Feed efficiency was 1.53, 1.49 and 1.49 kg FCM per kg of DM intake for treatment A, B, and C, respectively. For study 2, there was no difference ($P > .1$) in rumen pH, concentration of ammonia or total volatile fatty acids (VFA) measured at 0, 1, 3 and 6 hours post feeding. For treatments A, B, and C, average rumen pH was 6.20, 6.15 and 6.15 while the average low, 3 hours post feeding, was 6.01, 5.98 and 5.96. Across treatments, average ammonia concentration was 8.76, 19.69, 12.53, and 8.37 mg/dl of rumen fluid at 0, 1, 3 and 6 hours post-feeding.

Key Words: Direct Fed Microbial, Mid-Lactation, Ruminant

942 Effect of calcium source on ruminal soluble calcium and microbial fermentation. E. J. Baird^{*1}, V. Fellner¹, S. J. McLeod¹, J. W. Spears¹, and F. R. Valdez², ¹Department of Animal Science, North Carolina State University, Raleigh, ²Kemin Americas, Des Moines, IA.

A study was conducted to determine the effect of Ca level and source on ruminal soluble Ca concentration and microbial fermentation in continuous culture fermentors. Treatments consisted of control diet (0.18% Ca) or the control supplemented with 0.60% Ca from either: 1) CaCO₃, 2) Ca propionate-prilled (CaP, NutroCAL#8482) or 3) CaP-powder. Fermentors were fed 14 g DM/d of a diet (DM basis) consisting of 35% corn silage, 18% soybean meal, 15% corn, 22% cottonseed hulls, and 10% whole cottonseed. Following a 2-d stabilization period, fermentors were sampled over a 4-d collection period. Each treatment was replicated five times. Calcium supplementation of the control diet increased ($P < 0.01$) ruminal soluble Ca concentrations. Ruminal soluble Ca concentrations were higher ($P < 0.01$) in cultures receiving CaP treatments compared to CaCO₃. Ruminal pH was higher in Ca-supplemented diets compared to control ($P < 0.01$), and CaCO₃ was higher ($P < 0.05$) than CaP treatments. Digestibility of NDF was higher in CaP-prilled compared to control ($P < 0.06$), CaCO₃ ($P < 0.09$), and CaP-powder ($P < 0.05$) treatments. Total VFA production in ruminal cultures was increased ($P < 0.05$) by supplemental Ca. In response to Ca source, total VFA production was higher for CaP-prilled than CaCO₃ ($P < 0.01$) and CaP-powder ($P < 0.08$) treatments. Propionate production and molar proportion were higher ($P < 0.01$) in CaP than control or CaCO₃ treatments. Butyrate production was higher ($P < 0.01$) for CaP-prilled and CaCO₃ treatments compared to control and CaP-powder treatments. Molar proportion of butyrate was higher ($P < 0.01$) for CaCO₃ than the other treatments. Production and molar proportion of isovalerate was lower ($P < 0.01$) for CaP-powder compared to other treatments. These results indicate that both dietary Ca level and source affect soluble Ca concentrations and fermentation in continuous cultures of ruminal microorganisms.

Key Words: Microbial Fermentation, Calcium

Ruminant Nutrition: Dairy - Feedstuffs

943 Impact of feeding high free fatty acid whole cottonseed on milk yield and composition. J. K. Bernard^{*1}, J. Siciliano-Jones², and T. C. Wedegaertner³, ¹The University of Georgia, Athens, ²FARME Institute, ³Cotton Incorporated.

Whole cottonseed (WCS) is used as a source of energy, protein, and fiber by many dairy producers. The concentration of free fatty acids in the oil

(FFA) may be elevated after tropical storms delay harvest resulting in concentrations exceeding 12% of the oil. These seed are considered to be off quality. Limited data are available on the feeding value of off-quality WCS. Approximately 300 lactating Holstein cows were used in a 3 x 3 Latin square trial to determine the impact of feeding whole cottonseed

with different concentrations of free fatty acids in the oil. Cows were assigned to each pen by parity, DIM, and milk yield. Treatments included WCS with low (10.7% FFA, L), high (35.5% FFA, H) or a 50:50 blend of H and L (23.1 % FFA, M). During each 3-wk experimental period, pen intake was recorded daily, milk weights were recorded at each milking (3X) and milk samples were collected from each milking once weekly for analysis of milk fat, protein, and milk urea nitrogen (MUN). Dry matter intake and milk yield was similar for all treatments: 27.5 and 40.1; 27.4 and 40.2; and 27.7 kg/d and 39.9 kg/d for L, M, and H respectively. Milk fat concentration ($P < 0.001$) and yield ($P < 0.002$) were lower for cows fed H compared with L and M: 3.02 and 1.21; 3.13 and 1.26; and 2.87 % and 1.14 kg/d for L, M, and H, respectively. No differences were observed in concentration or yield of milk protein among treatments (average of 2.97% and 1.18 kg/d). Yield of energy corrected milk (ECM) was lowest ($P < 0.003$) for H reflecting the lower yield of milk fat (37.0, 37.6, and 36.0 kg/d for L, M, and H, respectively). Concentrations of MUN were lowest for L and highest for H ($P < 0.003$): 12.97, 13.12, and 13.42 mg/dl for L, M, and H respectively. The reduced milk fat and increased MUN suggest changes in ruminal fermentation, but the changes were not great enough to alter intake, milk yield, or milk protein synthesis.

Key Words: Whole Cottonseed, Milk Yield, Milk Composition

944 Utilisation of whole-crop pea silage in dairy cow rations as a potential protein source to replace soya bean meal. K. J. Hart*, R. G. Wilkinson, L. A. Sinclair, and J. A. Huntington, *Harper Adams University College, Newport, Shropshire, UK.*

The use of protein concentrates in ruminant diets is both essential and costly. With the consumer demand in the UK for high quality, low cost products, there is a need for a cheap and efficient protein source for inclusion into ruminant rations. Whole-crop pea (WCP) silage has the potential to fulfil this role, being a cheap and easy to grow crop, which can also be used in organic systems. In addition, the presence of condensed tannin in coloured flowered varieties of peas may confer protection of protein in the rumen. The aim of this experiment was to evaluate WCP silage as a replacement for soya bean meal. WCP silage was produced from a spring-sown crop (cv.Racer) which was cut after 13 weeks, wilted and ensiled with a bacterial inoculant. The three diets were ad lib grass silage (GS) and fermented whole-crop wheat (WCW, 50:50) with 8kg of soya based concentrate (GWS), or ad lib GS; WCW and WCP (25:25:50) with either 8kg/day soya based concentrate (PS) or 8kg wheat based concentrate (soya replaced with wheat, PW). Diets were offered to 9 pregnant Holstein-Friesian in late lactation in a latin rectangle design, with each period lasting 28 days. Intakes and performance traits were recorded over the last 7 days of each period. Silage dry matter intakes increased in cows fed diets containing WCP silage (12.0 vs 13.4 vs 13.0, s.e.d. 0.53 $P < 0.05$, GWS, PS and PW respectively) whilst concentrate dry matter intakes were similar across all treatments ($P > 0.05$). Milk yield did not vary significantly across the treatments (23.1 vs 23.8 vs 22.0, s.e.d. 0.86, $P > 0.05$, GWS, PS and PW respectively), although there was a significant increase of 0.08 kg/day in milk protein yield in cows fed PS (0.77 vs 0.85 vs 0.77, s.e.d. 0.032, $P < 0.05$, GWS, PS and PW respectively). Cows fed the control diet of GWS had higher nitrogen efficiency for milk production when compared to the diets containing WCP silage (27% vs 24% vs 24%, s.e.d. 0.01, $P = 0.01$). Results from this experiment suggest that 1kg DM of WCP silage can replace a daily portion of 1kg DM of soya bean meal. With WCP silage costing around 63/T DM, a considerable saving could be achieved

Key Words: Pea Silage, Dairy Nutrition

945 Replacement of blood meal with a supplement containing bacterial and fungal fermentation extracts in diets fed to mid-lactation dairy cows. C. S. Ballard*¹, P. Mandebvu¹, M. P. Carter¹, K. W. Cotanch¹, R. J. Grant¹, C. J. Sniffen², W. Rodee³, and L. Robinson³, ¹*W.H. Miner Agricultural Research Institute, Chazy, NY*, ²*Fencrest LLC Holderness, NH*, ³*Agriformulations, Inc., Waddington, NY*.

Lactational response to a commercial feed supplement containing bacteria and fungal fermentation extracts (Protein Edge[®]) in place of animal protein was measured using 40 primi- and multiparous midlactation (78 to 231 days in milk) Holstein cows in a crossover design study with two 28-d periods. Cows were blocked by parity and milk production and

assigned randomly to a control total mixed ration (TMR) containing blood meal (210 g/cow/day) and corn distillers grain (48 g/cow/day), or a TMR containing Protein Edge[®] (PE; 28 g/cow/day), soybean hulls (45 g/cow/day) and corn gluten meal (81 g/cow/day). In addition, the control TMR contained more Soy Pass compared with the PE TMR (810 vs. 163 g/cow/day). Diets were formulated such that the amounts of lysine and methionine in metabolizable protein in both TMR were close to the recommended levels of 7.2 and 2.2%, respectively, while maintaining a lysine to methionine ratio of approximately 3 to 1 (expressed as % of MP). The TMR contained 49% forages and 51% concentrates with 19% CP and 28% NDF. Milk production and composition from all cows was recorded during the fourth week of each period. Cows fed the control TMR containing blood meal and cows fed the TMR containing PE, respectively, produced 34.2 and 34.2 kg/d milk with 4.00 and 4.01% fat, 3.24 and 3.28% true protein, 4.72 and 4.69% lactose, 12.6 and 12.6 mg/dl milk urea N, and 281,000 and 223,000 somatic cell counts/ml, and 0.10 and 0.10 change in BCS per period ($P > 0.07$). In conclusion, when blood meal was replaced with PE and rations were reformulated to meet lysine and methionine, there were no differences in milk yield and milk composition by Holstein cows, showing that the PE product performed as well as blood meal when fed to supply similar concentrations of methionine and lysine posturally.

Key Words: Methionine and Lysine, Blood Meal, Dairy Cow

946 Replacement of alfalfa haylage with ensiled wet distillers grains and beet pulp in lactating dairy cows diets. A. D. Garcia*, K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings.*

Wet corn distillers grains (WDG) and wet beet pulp (WBP) are excellent feeds for ruminants. Energy in WDG is supplied by its high lipid and fermentable fiber content, whereas in WBP it results from highly fermentable carbohydrates. The objective of this research was to evaluate the effect on milk production of substituting alfalfa haylage with either one of two WDG/WBP blends. Nine cows (six Holstein and three Brown Swiss) with 92 ± 4 DIM were used in a 3×3 Latin square with 3-wk feeding periods. Experimental diets were: 1) control diet (C) which contained 17.2% DM alfalfa haylage; 2) treatment 1 (T1), where 21.7% DM of a 33% WDG and 66% WBP blend substituted for alfalfa haylage; and 3) treatment 2 (T2), where 24.5% DM of a 66% WDG and 33% WBP blend substituted for alfalfa haylage. All other feeds were maintained constant across treatments with the exception of dry DG, which was added at 10.2, 5.7, and 0% of the diet DM in C, T1, and T2, respectively, to balance for dietary CP. Diets were balanced for 16% CP, 20% ADF, 30% NDF, and 1.60 Mcal NEL/kg. Dry matter intake did not differ between treatments ($P > 0.10$). Feed efficiency tended to increase ($P < 0.07$) in cows fed T1 when compared to C. Cows fed T1 and T2 produced more milk (38.0 and 39.2 vs 35.7 kg/d; $P < 0.06$) when compared to C. Although cows fed C tended to have higher milk protein percentage ($P < 0.07$), milk protein yields were higher (1.2 and 1.3 vs. 1.1 kg/d; $P < 0.05$) for cows fed T1 and T2. Milk fat percentage decreased for cows fed T1 and T2 compared to C (3.1 vs. 3.6%; $P < 0.01$), however milk fat yield did not differ across treatments ($P > 0.10$). Results from this experiment suggest that blends of WDG and WBP can substitute for alfalfa haylage in dairy cow diets while improving total milk production and milk protein yield.

Key Words: Wet Beet Pulp, Wet Distillers Grains, Dairy Cows

947 Increasing wet distillers grains in the diets of dairy cows on milk production and nutrient utilization. K. F. Kalscheur*, A. L. Justin, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings.*

The objective of this experiment was to determine lactation performance and nutrient utilization in dairy cows fed increasing concentrations of wet corn distillers grains (WDG). Four ruminally cannulated multiparous Holstein cows averaging 117 DIM were used in a 4×4 Latin square design with 4-wk periods. Wet distillers grains were included at 10, 20, 30, or 40% of the diet DM. The forage portion of the diets was constant and consisted of 30% corn silage and 15% bromegrass hay (DM basis). Soybean meal, soybean hulls, and animal fat were replaced by WDG as inclusion rates increased. Diets (DM basis) averaged 17.8% CP, 41.7% NDF, 22% ADF, 6.5% EE, and 1.65 Mcal/kg. Diet DM decreased (49.5, 45.8, 41.9, and 40.4% for 10, 20, 30, and 40% WDG, respectively) as diet WDG increased. Dry matter intakes decreased (P

< 0.02) as diet WDG increased in the diets (25.7, 24.6, 22.0, and 18.4 kg/d). Milk production decreased (40.1, 36.7, 34.9, and 34.8 kg/d; $P < 0.01$) as WDG increased from 10 to 40% of the diet. Milk fat percentage (2.64, 2.96, 2.93, and 2.64%; $P < 0.03$) and milk protein percentage (3.21, 3.24, 3.15, and 3.34%; $P < 0.06$) responded quadratically as WDG increased. Milk component yield and MUN did not differ across diets. Total tract digestibilities of DM, OM, ADF, and NDF did not differ ($P > 0.10$) with increasing levels of WDG. Total tract digestibility of CP increased (59.5, 64.7, 67.7, and 67.3%; $P < 0.03$) with increased WDG in the diet. Nitrogen intake (691, 708, 645, 534 g/d) tended to decrease ($P < 0.09$) due to the decrease in DMI. As a result, the response of N efficiency to the addition of WDG in the diets tended to be quadratic (28.0, 25.0, 26.9, 34.2%; $P = 0.10$). As WDG increased in the diets, calculated fecal N decreased ($P < 0.01$), but urinary N was not different. Nutrient digestibilities of the diets with the exception of CP were unchanged across diets. Milk production decreased when WDG was added to the diet above 10% of the dry matter.

Key Words: Wet Distillers Grains, Nutrient Digestibility, Nitrogen Utilization

948 Dietary factors influencing milk protein content of cows fed grass silage-based diets. P. Huhtanen^{*1} and J. Nousiainen², ¹MTT Agrifood Research Finland, ²Valio Ltd, Valio, Finland.

Protein is the most valuable component of milk, and therefore there is an economical incentive to enhance milk protein content (MPC). A mixed model regression analysis was conducted to investigate the relationship between diet parameters and MPC(g/kg). Data consisted of 335 treatment means from 46 studies. Diets were based primarily on grass silage and concentrate supplements containing cereal grains and oilseed meals. Because part of CP is NPN, MPC values were corrected for urea (MPCc). Dietary parameters (g/kg DM) were CP, ether extract (EE), starch, non-structural CHO, lactic acid (LA), NDF, metabolizable protein (MP), protein balance in the rumen (PBV) and ME (MJ/kg DM). Single parameters poorly described the variation in MPC. MP was the best single predictor of MPC ($R^2=0.40$), and EE of MPCc ($R^2=0.23$). Increases in EE and LA had a negative effect on MPC and MPCc. The best equations based only nutrient concentrations were: $MPC=23.9-0.045EE-0.007LA+0.117MP-0.005PBV$ ($R^2=0.63$; $SE=0.44$) and $MPCc=24.2-0.042EE-0.007LA+0.105MP-0.017PBV$ ($R^2=0.61$; $SE=0.45$). Single intake parameters (total DMI, ME and MP intake) explained 62-69 and 56-68% of the variation in MPC and MPCc, respectively. Bivariate models including CP or PBV, in addition to one intake parameter, suggested that a large proportion of increased MPC in response to higher dietary CP concentration was due to increased milk urea. Carbohydrate composition of the diet had few significant effects on MPC, when variation in ME of MP intake was excluded. The best predictive models included: $MPC=24.0+0.018MEI-0.051EE-0.007LA+0.075MP$ ($R^2=0.76$; $SE=0.39$), and $MPCc=26.0+0.022MEI-0.058EE-0.008LA+0.039MP$ ($R^2=0.74$; $SE=0.40$), respectively. Lower MPC with increased EE resulted primarily from dilution. The effect of LA is related to the lower energy supply of silage fermentation acids than carbohydrates for rumen microbes. It is concluded that milk protein content was largely related to energy and MP intake. At a constant ME intake, MPC can be increased by avoiding excessive amounts of fat, restricting in-silo fermentation and increasing MP content.

Key Words: Grass Silage, Milk Protein

949 Effects of NDF from alfalfa hay, grass hay, straw, and whole cottonseed on performance of lactating cows. P. B. Bucci^{*}, M. L. Eastridge, and C. V. D. M. Ribeiro, *The Ohio State University, Columbus.*

Straw is used in some rations in the field for lactating dairy cows as a source of effective fiber; however, limited data are available on using straw versus legume or grass hay on an equivalent forage NDF basis. Four ruminally cannulated multiparous Holstein cows (276 DIM) were used in a 4 x 4 Latin square design, with the following diets fed ad libitum: 1) 17% forage NDF (FNDF) from corn silage (CS) and alfalfa hay (11.7% of DM), 2) 17% FNDF from CS and grass hay (7.0% of DM),

3) 17% FNDF from CS and wheat straw (5.2% of DM), and 4) 12.8% FNDF from CS with 10% whole, linted cottonseed (WCS) in the diet. Corn silage was held constant at 35.7% of the diet. Periods were 21 d, with the last 10 d used for animal performance data. Cows were milked twice daily, and four consecutive milkings per week were sampled for analyses of milk components. Rumen samples for VFA and pH were taken at 6 h post-feeding on d 19 and 20 of each period. The DM intake was similar among treatments (24.7 kg/d), but milk yield was lower for straw than grass and WCS (22.7, 23.5, 21.6, and 24.0 kg/d for alfalfa hay, grass hay, straw, and WCS, respectively). Yields of fat and protein and concentrations of fat (4.28%), protein (3.54%), and urea nitrogen (14.46 mg/dl) in milk did not differ among treatments. Rumen pH was similar among treatments at 6.25. Ruminal proportion of acetate was lower and propionate higher for WCS. The three sources of forage NDF appeared to result in similar ruminal conditions. Data are not available yet to explain the lower milk yield with the straw. Although WCS lowered the acetate:propionate ratio, ruminal pH remained adequate and milk fat percentage was not depressed.

Key Words: Forage NDF, Whole Cottonseed, Straw

950 Rumen fill and intake regulation of grazing dairy cows under continuous stocking. H. Z. H. Taweel^{*}, B. M. Tas, J. Dijkstra, and S. Tamminga, *Department of Animal Sciences, Animal Nutrition Group, Wageningen University, Wageningen, The Netherlands.*

This experiment aimed at studying the possible role of rumen fill in signalling the termination of the three main grazing bouts of dairy cows. For this purpose the day was divided into three main periods (6:00-12:00 h, 12:00-18:00 h and 18:00-24:00 h) where the three main grazing bouts (dawn, afternoon and dusk) of dairy cows usually occur. Four rumen-cannulated dairy cows were used in a repeated measures design, with time of day as the within subjects factor. The cows had access to a 1-ha grass sward under a continuous stocking system. To estimate rumen pool sizes, dry matter intake (DMI), eating time (ET), bite rate (BR), bite mass (BM) and intake rate at the three bouts, cows were rumen-evacuated at 6:00, 12:00, 18:00 and 24:00 h and jaw recorders were fitted to the cows between these time points. To estimate clearance rate (Kcl) cows were deprived of food from 24:00 till 8:00 h next morning, when rumen evacuations were performed again. Rumen pool sizes were larger ($P < 0.01$) at 24:00 h compared to other times of the day (9.5 vs 13.5 kg DM). Because rumen evacuations in the present study were performed at fixed time points during the day and not immediately when grazing ceased, it was important to estimate the fluctuation in rumen fill between the measured points if we want to draw valid conclusions concerning its role in regulating the cessation of grazing. To estimate rumen fill fluctuation during the day, a dynamic model was constructed based on the measured ET, BR, BM, and Kcl. The model consisted of one state variable, which was the rumen NDF pool (QNDF). QNDF receives input from feed intake and its output is disappearance from the rumen through Kcl. Despite the fact that cows grazed 132 min and 175 min during the morning and afternoon grazing bouts, respectively, QNDF did not reach the value it reached at 24:00 h. This indicates that dairy cows interrupted these two grazing bouts long before reaching their maximal rumen fill capacity. However, rumen pool sizes were always maximal at the time when the dusk grazing bout ceased indicating that rumen fill is more likely to play a major role in signaling the termination of the dusk grazing bout.

Key Words: Rumen Fill, Intake, Grazing

951 Corn grain endosperm type and brown midrib 3 corn silage: site of nutrient digestion and ruminal digestion kinetics in lactating dairy cows. C. C. Taylor^{*} and M. S. Allen, *Michigan State University, East Lansing.*

Effects of corn grain endosperm type and the brown midrib 3 mutation in corn silage on site of nutrient digestion and ruminal digestion kinetics in cows were evaluated. Eight ruminally and duodenally cannulated Holstein cows (72 ± 8 DIM; mean \pm SD) were used in a duplicated 4x4 Latin square design with a 2x2 factorial arrangement of treatments. Grain treatments were dry corn grain from hybrids with floury

or vitreous endosperm; silage treatments were corn silage from a hybrid with the *bm3* mutation or its isogenic control hybrid without the *bm3* mutation. Diets contained 26% neutral detergent fiber and 17% crude protein. Treatment corn grain and silage supplied 23% and 38% of the diet DM, respectively. Interactions of main treatment effects did not occur for any measures of nutrient digestibility. Floury endosperm grain increased total tract OM digestibility versus vitreous grain (75.2 vs. 71.9%; $P < 0.01$) primarily by increasing starch digestibility. Floury grain increased apparent ruminal starch digestibility (57.0 vs. 35.0%; $P < 0.01$) compared to vitreous grain because of a 70% increase in starch digestion rate (21.9 vs. 12.9%/h; $P < 0.01$) and a tendency for decreased ruminal starch passage rate (16.2 vs. 21.2%/h; $P < 0.10$). Post-ruminal starch digestibility (% of intake) was 39.3 and 56.8% ($P < 0.03$) for floury and vitreous grain, respectively, but as a % of duodenal flow, floury grain was more digestible than vitreous grain (90.8 vs. 83.6%; $P < 0.01$). Although substantial compensatory post-ruminal starch digestion occurred for vitreous diets, replacing vitreous grain with floury grain increased total tract starch digestibility from 91.7 to 96.3% ($P < 0.001$). Brown midrib corn silage increased total tract NDF digestibility compared to control silage (51.1 vs. 45.8%; $P < 0.02$) by numerically increasing ruminal and post-ruminal NDF digestibility, but digestion and passage rates of potentially digestible NDF did not differ across treatments. Endosperm type of corn grain can affect site and extent of starch digestion.

Key Words: Endosperm, Brown Midrib, Digestion

952 Effects of physically effective NDF on chewing activity and rumen pH of dairy cows fed diets based on barley silage. K. A. Beauchemin* and W. Z. Yang, *Research Center, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

A study was conducted to investigate the effects of physically effective (pe) NDF content of dairy cow diets on chewing activity and rumen pH. The study was designed as a double 3 x 3 Latin square using six lactating dairy cows with ruminal cannulas. Three levels of dietary peNDF (high, medium and low) were compared. The diets contained whole crop barley silages prepared with two theoretical lengths of cut (TLC): coarse (3/8") and fine (3/16"). The high, medium and low peNDF diets were formulated using coarse silage, equal proportions of coarse and fine silages, or fine barley silage, respectively. The peNDF content of the diets was determined as the proportion of the TMR (as-fed) retained on the 0.75" and 0.31" screens of the Penn State Particle Separator multiplied by dietary NDF content (DM basis). The peNDF contents were 13.8, 11.8 and 10.5% (DM basis) for the high, medium and low diet, respectively. Increasing peNDF content of diet had no effect on eating time (280, 247 and 267 min/d for high, medium and low, respectively) but quadratically increased ($P < 0.05$) ruminating time (440, 465 and 363 min/d for high, medium and low, respectively) and total chewing time (720, 712 and 630 min/d for high, medium and low, respectively). Mean pH, area under the pH curve, and duration of pH < 5.8 or < 5.5 were not affected by the peNDF content of diets. Unexpectedly, the peNDF content of the diet and ruminating time were negatively correlated to mean rumen pH ($r = -0.42$; $P < 0.15$) but positively correlated to the time during which pH was below 5.5 ($r = 0.40$, $P < 0.15$), an indicator of rumen acidosis. The results suggest that increasing the peNDF content of the diet can increase chewing activity which reduces the risk of acidosis. Dairy cows fed barley silage as the predominant forage source require a minimum dietary peNDF of 12% of DM.

Key Words: Physically Effective NDF, Chewing, Rumen pH

953 Effect of barley and its amylopectin content on ruminal fermentation and nitrogen utilization in lactating dairy cows. A. E. Foley*¹, A. N. Hristov¹, A. Melgar¹, J. K. Ropp¹, R. P. Etter¹, C. W. Hunt¹, and K. Huber², ¹*Department of Animal and Veterinary Science, University of Idaho, Moscow,* ²*Department of Food Science and Toxicology, University of Idaho, Moscow.*

The objective of this study was to evaluate the effect of partial substitution of corn grain by either normal or high-amylopectin (waxy) barley on ruminal fermentation, digestibility of nutrients, nitrogen (N) losses, and ammonia utilization in lactating dairy cows. Six late-lactation ruminally and duodenally cannulated Holstein cows were allocated to dietary

treatments in a replicated 3 x 3 Latin square design. Diets contained (DM basis): 40% corn grain (C), 30% normal barley and 10% corn (B), and 30% waxy barley and 10% corn (WB). All grains were steam-rolled. Barley grain had a greater rate of in situ ruminal DM degradability than either waxy barley ($P < 0.05$) or corn grain (trend at $P = 0.105$). Ruminal pH and VFA concentrations were not different ($P > 0.05$) between treatments, but ammonia and acetate concentrations were less ($P < 0.05$) in C compared to B and WB. Microbial protein synthesis (MPS) and efficiency were not affected ($P > 0.05$) by treatment. Ruminal and total tract N digestibility were reduced ($P < 0.05$) in C compared to B. Diet B resulted in the greatest ($P < 0.05$) N intake, and total N loss was greater ($P < 0.05$) in WB than in B. Plasma urea N concentration was not different ($P > 0.05$) among diets, but milk urea N (MUN) was greater ($P < 0.05$) in B and WB compared to C. Ruminal ammonia (labeled with ¹⁵N) utilization for MPS or milk protein was not affected ($P > 0.05$) by treatment. Tracer excretion in milk protein was greater ($P < 0.05$) in C compared to WB. Milk yield and composition were not affected ($P > 0.05$) by treatment. Ruminal ammonia and MUN concentrations suggested less efficient utilization of dietary N in B than in C, but overall, N losses were not affected by grain type. Inclusion of WB in the diet resulted in increased N losses compared to B and reduced efficiency of utilization of ruminal ammonia for milk protein synthesis compared to C.

Key Words: Barley, Corn, Dairy Cow

954 A nutritional evaluation of assiniboia oat, baler oat, and rosier barley silage for dairy cattle. T. L. Heck*, D. A. Christensen, J. J. McKinnon, and P. Yu, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

Three studies were conducted to evaluate the nutritional value of oat silage (*Avena sativa*) for use in dairy cattle rations. A total tract digestibility study using 18 lambs in a complete random design was conducted to determine the digestibility of dry matter (DM), organic matter (OM), crude protein (CP), crude fat (EE), neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) of Assiniboia (ASS) and Baler (BAL) oat silage compared to Rosier (ROS) barley silage. An *in situ* study was conducted using a non-lactating fistulated cow to determine rumen kinetic parameters of carbohydrate fractions. A dairy production trial was carried out using 9 lactating Holsteins at 90±20 DIM averaging 43 kg/d milk yield in a triple 3x3 Latin square design to determine the effect on milk yield and composition when fed 48% of ASS, BAL, and ROS silage (DM) in a total mixed ration (TMR). Lamb voluntary intake was higher ($P < 0.05$) for ROS compared to the two oat varieties, however BAL was higher than ($P < 0.05$) ASS. Digestibility of DM and OM were significantly different across treatments (DM 71.8, 65.2, 60.9, OM 73.9, 66.9, 63.3 for ROS, ASS, and BAL, respectively). CP digestibility was greater ($P < 0.05$) for ROS compared to the oat varieties. The digestibility of NDF, ADF, and ADL, and EE were similar between ROS and ASS treatments and both were higher ($P < 0.05$) than BAL. Dairy DM intake was similar across all dietary treatments. Milk yield was similar for ASS and BAL (41.6 kg/d), and 6% lower ($P < 0.05$) than ROS. Milk fat percentage was greater ($P < 0.05$) for ASS and BAL compared to ROS, which resulted in similar milk fat yields and 3.5% fat corrected milk among treatments. Milk protein yield and percentage were higher ($P < 0.05$) for ROS compared to ASS and BAL. It was concluded that oat silage could be substituted for barley silage as a forage source for dairy cattle rations.

Key Words: Silage, Dairy, Digestibility

955 Lactation performance and milk fatty acid profile of dairy goats fed four different forage species. A. Doyon*¹, G. F. Tremblay², and P. Y. Chouinard¹, ¹*Universite Laval, Quebec, QC, Canada,* ²*Agriculture and Agri-Food Canada, Quebec, QC, Canada.*

Forages provide substantial lipids in ruminant diets, and more than 50% of total fatty acids in certain forage species are C18:3. Our objective was to evaluate the effect of feeding four different forages on milk production and composition in dairy goats. Two grass [timothy (*Phleum pratense*), Italian ryegrass (*Lolium multiflorum*)] and 2 legume [alfalfa (*Medicago sativa*), white clover (*Trifolium repens*)] forages were harvested as silage. The C18:3 concentration in those forages was 8.8, 18.6,

7.8, and 9.8 mg/g DM, respectively. Twelve dairy goats of 3 different breeds (4 Alpine, 4 Saanen, and 4 Toggenbourg) that averaged 216 days in milk were used in a replicated 4 x 4 Latin square arrangement with 21-d periods. Goats were offered ad libitum access to a basal diet consisting of timothy, ryegrass, alfalfa, or white clover silage, supplemented with 180 g/d of a blend of rolled barley (65%), Topsoy® (22%), molasses (2%), and vitamin and mineral mix (11%). Milk yield and milk protein content were decreased, and fat content was increased with timothy as compared with ryegrass, alfalfa, and white clover ($P < 0.01$). Milk fat yield was not affected by forage type. Feeding grass forages decreased ($P < 0.01$) the proportion (% by weight) of C10:0, C12:0, C14:0, and C16:0, and increased the proportion of C18:0 and *cis*-9 C18:1 in milk fat as compared with legume forages. The C18:3 concentration was higher for alfalfa (1.68%), intermediate for ryegrass (1.59%) and white clover (1.60%), and lower for timothy (0.91%) ($P < 0.01$). Concentration of *cis*-9, *trans*-11 C18:2 was higher for ryegrass and alfalfa (0.47 and 0.45%, respectively), and lower for timothy and white clover (0.36 and 0.33%, respectively) ($P < 0.01$). The concentration of *trans*-11 C18:1 was higher for ryegrass (0.88%), intermediate for timothy (0.71%) and alfalfa (0.73%), and lower for white clover (0.53%) ($P < 0.01$). The concentration of *cis*-9, *trans*-11, *cis*-15 C18:3 was higher with ryegrass (0.048%) as compared with timothy, alfalfa, and white clover (0.009, 0.012, and 0.013%, respectively) ($P < 0.01$). The fatty acid profile of milk fat can be modified by feeding different forage species to dairy goats.

Key Words: Conjugated Linolenic Acid, Omega-3 Fatty Acid

956 Effects of feeding flaxseed on fatty acid composition in milk and cheese in dairy ewes. R. Zhang*, A. F. Mustafa, and X. Zhao, *McGill University, Ste-Anne-De-Bellevue, QC, Canada.*

A study was conducted to determine the effects of feeding various levels of flaxseed to lactating ewes on milk fatty acid composition, cheese yield and cheese fatty acid composition. One hundred and twenty lactating ewes (Suffolk East Friesian) were divided into 4 groups and were randomly assigned to one of 4 different isonitrogenous concentrates. The concentrates contained 0% (C1), 8% (C2), 12% (C3) and 16% (C4) flaxseed. The EE content (DM basis) of the concentrates was 3.2, 5.4, 7.4 and 9.4%, respectively. All animals were fed 1 kg of concentrate each plus ad-libitum intake of alfalfa hay. Animals were fed in pens. Results showed flaxseed supplementation had no effect on milk protein, lactose and casein percentages. However, milk fat percentage was higher ($P < 0.05$) for ewes fed C3 and C4 than for those fed C1 and C2. Cheese yield was 12% higher for ewes fed C3 than for those fed C1. However, flaxseed supplementation had no effect on cheese fat or protein percentage. Flaxseed supplementation linearly decreased ($P < 0.05$) the concentrations of medium chain and saturated fatty acids and increased ($P < 0.05$) those of long chain, mono- and poly-unsaturated fatty acids. Conjugated linoleic acid (CLA) and omega-3 fatty acid in milk and cheese were linearly increased ($P < 0.01$) as a results of flaxseed supplementation. Feeding C4 increased CLA and omega-3 fatty acids of milk by 66 and 75%, respectively. The corresponding increases in cheese were 67 and 74%, respectively. It was concluded that feeding flaxseed to dairy ewes can increase health-promoting fatty acids without major changes in milk fat or protein percentages

Key Words: Dairy Ewe, Fatty Acids, Cheese

ABSTRACTS
ADSA Student Affiliate Division

* Author Presenting Paper

Original Research/Independent Study Undergraduate Paper Presentations

957 The luteolytic potential of reduced doses of prostaglandin. J. Brinkerhoff*, R. Silcox, J. Donley, and C. Kubo, Brigham Young University, Provo, UT.

Prostaglandin (PGF) and its analogs have greatly contributed to managing the reproductive performance of dairy herds. The most effective route of administration as well as the minimal dose requirement for induction of luteolysis has been investigated previously. This study was designed to compare the luteolytic response of lactating cows treated with a reduced dose of Prostamate administered in the ischioanal fossa versus the recommended dose given intramuscularly. Non-pregnant lactating Holstein cows with a functional corpus luteum (CL > 20 mm as determined by transrectal ultrasonography) were sorted by lactation into three groups; 1st (n=40), 2nd (n=40), 3rd and greater (3+) lactation (n=40). Cows within lactation group were paired. One cow of each pair was randomly assigned to be treated with 25 mg Prostamate intramuscularly (IM group) or with 15 mg Prostamate given in the ischioanal fossa (IRF group). Ovaries of cows were examined by ultrasound 72 hours post-injection to determine luteal regression. The functionality and regression of the CL were confirmed through analysis of serum progesterone concentrations in blood samples collected by tail venipuncture at the time of PGF administration, then 24 and 72 hr later. Tail heads of all cows were chalked at the time of PGF treatment. Estrus was detected daily for seven days post-PGF by assessing chalk removal. Luteal regression was induced in 103/120 cows. Luteolytic response was not affected by lactation number ($P > .05$). Route of administration and dose of prostaglandin did not affect response rate ($P > .05$; IRF:50/60, 83%; IM:53/60, 86%). Overall estrus detection rate for all cows given PGF was 43% (IM:29/60, 48%; IRF:23/60, 38%; $P > .05$). Estrus detection rate among cows that responded to PGF did not differ due to treatment (IM:29/53, 55%; IRF:23/50, 46%; $P > .05$). The IRF is a viable alternate route of administering a reduced (60% of normal) dose of PGF to lactating dairy cows since both luteolysis and estrus are induced at rates comparable to that attained with a normal dose administered IM.

Key Words: Cattle, Luteolysis, Prostaglandin

958 Evidence for differential degradation of α_s - and β -casein in milk from mastitic quarters. K. M. Matson*, A. C. W. Kauf, A. L. Magliaro, and R. S. Kensinger, The Pennsylvania State University, University Park.

Mastitis decreases the yield of cheese from milk through the proteolytic degradation of milk casein. Our objective was to compare the changes in the pattern of proteins seen in mastitic milk samples caused by different pathogens. Milk samples were aseptically collected from inflamed and control quarters of seven mid-lactation Holstein cows upon diagnosis of clinical mastitis. Bacterial pathogens isolated included *E. coli*, *Strep. non-ag. spp.*, *Staph. spp.*, and gram-positive spp. Milk yield data was collected before and after diagnosis. Milk protein was determined by Lowry assay, and samples were analyzed by SDS-PAGE in 4 M Urea. Mean milk yields for the -5, 0, and +5 milkings relative to diagnosis of clinical mastitis were 20.2, 13.7, and 18.5 kg/milking (± 2.2 SEM), respectively. There was a consistent trend for increased total protein in mastitic compared to control milk samples. Degradation of caseins was significant in all of the mastitic milk samples. Densitometric analysis of bands in gels from infected versus control milk samples indicated that there was a reduction of 37.9 ± 21.4 % in α_s -casein, with somewhat less degradation of β -casein. Degradation of α_s -casein was more extensive than that of β -casein, and this trend was common across pathogens. As further evidence of proteolytic activity, smaller molecular weight fragments appeared in the mastitic milk samples. In addition, an increase in immunoglobulins and albumin in mastitic milk was apparent. Results show that the degradation of α_s - and β -caseins are consistently observed among the mammary pathogens detected.

Key Words: Casein, Mastitis, Proteolysis

959 Cottage cheese manufactured using transglutaminase enzyme for increase in yield. K. Nielsen* and D.R. Henning, South Dakota State University, Brookings.

The purpose of this study was to confirm and quantitate the recovery of whey proteins from skim milk into cottage cheese curd when using

a food grade enzyme, transglutaminase. Other food processing methods have used this enzyme to crosslink proteins in the presence of calcium. The enzyme has been used to produce a curd. In our study, three replicate trials with unfortified skim milk and direct set cottage cheese manufacturing were completed. Experimental vats were manufactured using 10 units of transglutaminase enzyme per gram of total protein in the skim added immediately after the glucono delta lactone acidogen. Three washes of the cooked curd were completed. Samples of the skim milk, whey, wash waters, and curd were collected for a mass balance. All trials resulted in more protein recovery in the experimental cheese compared with the control cheese. The magnitude of the increased recovery was not significant. All experimental vats contained less protein in the whey than the corresponding control; however the magnitude of decreased protein was not significant.

Key Words: Cottage Cheese, Yield, Transglutaminase

960 Analysis of financial measures comparing 3 management styles. W. T. Wencil* and G. Hadley, *University of Wisconsin, River Falls.*

The objective of this research was to determine if management style influenced profitability. The management options compared included: Management Intensive Rotational Grazing (MIRG), a stored feed group, and a mixed feeding group. Survey results were used to define management style. MIRG was defined as a producer who used pasture as the major forage source of feed. The stored feed group was defined as farms that had no pasture access for animals. Finally the mixed feeding group was defined as farms that provide minimal grass for grazing, but pastures are not managed intensively. The number of farms whose survey results indicated the different management styles were: MIRG-30 farms, stored feed-226 farms, and mixed feeding-26 farms. There were nineteen different financial ratios used in this research; they dealt with issues of: liquidity, solvency, profitability, repayment capacity, and financial efficiency. Dupont analysis was performed on the financial ratio measures calculated from the Agricultural Financial Advisor (AgFA) database. This database contains the financial information of 600 Wisconsin dairy farms. The results were analyzed using a statistics program to test for statistical significance between results. Based on the results, MIRG is at least a competitive option for dairy producers.

Key Words: Financial, Grazing

Dairy Production Undergraduate Paper Presentations

962 Leptin: What is its role in the dairy cow? D. C. Barbour* and E. H. Jaster, *California Polytechnic State University, San Luis Obispo.*

Dairy cows in early lactation experience a negative energy balance that often pre-disposes them to metabolic disorders. Ketosis, periparturient paresis, and displaced abomasum are examples of these disorders that arise from insufficient energy levels at parturition and freshening. Negative energy balance occurs in the dairy cow because the amount of energy expended for body maintenance and production exceeds the amount of energy available from dietary sources. Leptin is a peptide hormone produced by white adipose tissue that acts on the hypothalamus as its primary target organ. Leptin has been demonstrated to be closely associated with metabolic traits that maintain homeostasis despite negative energy balances in early lactation. Leptin is also thought to regulate processes that are highly dependent on positive energy supply. Some of these are developmental processes which include the onset of puberty, ovarian function, and formation of mammary secretory tissue, as well as other processes including responses to stress and general reproductive and immune functions. Research has determined that leptin serves as a mediator of nutrition, and an indicator of nutritional status and body conditioning in dairy cattle. Recent discoveries in nutritional biochemistry and DNA technology indicate that leptin has been shown to contribute to fat deposition, nutritional status, reproductive function, and immune response in dairy cattle.

Key Words: Leptin, Dairy Cattle

961 Wastewater treatment to reduce phosphorus losses from dairy farms. L. D. Hughes*, K. F. Knowlton, N. G. Love, A. M. Gamboni, and C. M. Parsons, *Virginia Polytechnic Institute and State University, Blacksburg.*

Dairy farms are a major source of phosphorus (P) contamination of surface water. One approach to reduce P runoff from farms is to apply biological wastewater treatment techniques to reduce the nutrient content of land-applied waste. Enhanced biological P removal (EBPR) is a system used to reduce the P content of municipal waste. EBPR involves treating waste in a reactor with alternating anaerobic and aerobic conditions. P-accumulating microorganisms in the waste sequester P, yielding a P-depleted liquid and a P-enriched biomass for export. Our objectives were to evaluate the compositional suitability of dairy manure for EBPR, and to evaluate the effects of diet and manure separation on parameters important to reactor design. Waste samples were collected from 9 cows fed a high P diet (0.47%P), a low P diet (0.32%P), or low P with exogenous phytase (0.32%P), in a Latin square design. Total collection of urine and feces was conducted, a mixed slurry was created, and slurry was separated mechanically to generate liquid effluent. Slurry and effluent samples were analyzed for P and chemical oxygen demand (COD). COD:P, reflecting energy available to drive P removal, was calculated. Phytase had no effect on waste composition, but the P content of slurry and effluent from cows fed low P (with and without phytase) was lower than from cows fed high P (224 and 242 vs. 375 mg/l), and the COD content tended to be higher (47,078 and 51,081 vs. 45,282 mg O₂/l; P < 0.09). The COD:P ratio of all wastes was sufficient to support EBPR, but waste from cows fed low P had a higher COD:P ratio than cows fed high P (310:1 and 289:1 vs. 149:1). Effluent had less COD and P than slurry, but the COD:P ratio was similar in the two wastes. These results indicate that dairy manure slurry and effluent will support EBPR, and that diet affects waste composition in a way that will affect reactor design. More work is needed to assess reactor performance and the economic feasibility of applying EBPR to dairy waste.

Key Words: Enhanced Biological Phosphorus Removal, Wastewater Treatment, Manure Composition

963 Managing an ovulation synchronization program with PCDART. J. C. Roberts*, *Louisiana State University, Baton Rouge.*

Ovulation synchronization is the use of exogenous hormones to induce the onset of ovulation in dairy cattle. Ovulation synchronization is a common practice on many US dairy farms. It can increase profitability on a dairy farm by reducing the average days to first breeding and consequently the average days open per cow on the farm. It can also improve the labor efficiency on the farm by reducing the need for heat detection. Ovulation synchronization requires that specific hormonal events be given to individual animals at specific time intervals. One disadvantage of using ovulation synchronization is the difficulty in coordinating several events associated with the protocol on a large number of animals in a dairy herd when different animals require different events on a particular day. Another disadvantage of using ovulation synchronization is the need to keep accurate records on which events were given to which animals during a given time frame. There would be no way of knowing which event an animal should receive at what time without this information. This would quickly render the program ineffective. PCDART is a computerized record keeping system for use in dairy herds. PCDART is used to manage all of the information recorded on individual animals such as milk production, breeding, calving, etc. PCDART can also be used to manage ovulation synchronization programs in a dairy herd. Dairy farmers can use default ovulation synchronization protocols that are built into the program or they can design their own protocols. After setting up an ovulation synchronization protocol the farmer wants to use, they then tell PCDART which cows are going to be synchronized. PCDART will then create daily or weekly reports telling the farmer which cows receive which hormonal treatments on a given day. This process greatly reduces the amount of time the farmer has to spend de-

termining when to give each animal a particular treatment. This allows farmers to utilize their time resources more efficiently and greatly improves the overall potential for success using ovulation synchronization.

Key Words: Ovulation Synchronization, PCDART, Dairy Management

964 Factors affecting fertility rates in embryo transfers. J. Hockney*, *North Carolina State University, Raleigh.*

Such reproductive technologies as artificial insemination and embryo transfer are becoming increasingly popular in the Dairy industry, greatly increasing the number of offspring from elite bloodlines and therefore improving the overall genetics of the industry. In this presentation, the procedure for embryo transfers will be discussed, including a variety of techniques, and the corresponding fertility rates associated with different protocols. These techniques vary from the use of fresh or frozen embryos, environmental factors, the use of bST, freezing and thawing methods, and surgical transfer. Through this data, one hopes to gain a greater understanding of the embryo transfer protocol, thus increasing success rates and therefore making a more economical procedure.

Key Words: Embryo Transfer

965 Effects of pasteurization on colostrum quality. M. L. Moody*, *Pennsylvania State University, University Park.*

Colostrum intake is essential for the development of passive immunity in the neonatal bovine because placental structure does not allow in utero transfer of antibodies from dam to fetus. For this reason calves must ingest an adequate amount of colostrum containing high levels of antibodies within hours after birth. Poor colostrum management may cause calves to consume pathogenic organisms such as *Mycoplasma* or *Mycobacterium paratuberculosis*. A large percentage of dairy producers pool colostrum from fresh cows, increasing this risk of disease spread by creating a mix of uncertain antibody contents and pathogenic bacteria. Pasteurization may present an alternative to calf raisers who pool colostrum when attempting to reduce disease transmission from dam to calf by killing pathogenic bacteria through heating colostrum to high temperatures. While pasteurization may rid colostrum of disease causing organisms, it may also reduce the concentration of Immunoglobulin G, the main antibody whose absorption leads to passive immunity in calves. Godden (2003) reported IgG concentrations were reduced by 58.5% in 95 L batches and 23.6% in 57 L batches of pasteurized colostrum.

Key Words: Pasteurization, Colostrum

966 Got Milk Insurance? L. B. Core*, *University of Kentucky, Lexington.*

Dairy producers nationwide continually struggle with the volatility of the milk market. From the record high prices of 1998 and 1999, to the devastating low prices of 2000, and the rebound of 2001, producers constantly have to strike a balance between enjoying the highs and budgeting for the lows in milk prices. However, another option is available to producers. Insuring milk prices with forward, futures, and options contracts rather than accepting the cash market is a viable option for many dairy producers. These three alternatives do not guarantee maximum profit, but instead allow producers to budget more effectively as they are better able to manage returns. Furthermore, securing long-term contracts for feed ingredients, hay, fuel, and other inputs to manage input cost will ensure the producer isn't challenged by unexpected price fluctuations. Each marketing alternative can be equally effective when ensuring prices; however, when choosing which alternative to employ, it is important to consider the individual needs of the producer. Dairy operators nationwide have enjoyed positive economic returns from the use of contracts. A Wisconsin family who milk approximately 400 Jerseys increased their profit margin by \$34,000 by using the contract method over their regular cash market method. Moreover, producers who had 200,000 lbs. of Class III milk with 3.5% butterfat contracted at \$12.00 for 2001 and 2002 made \$19,600 over the cash market value in the two year period. As impressive as these numbers are, everyone knows that nothing in life is a sure thing, including forward, futures and options contracting. However, these three alternatives do help to insure a long-term future for many dairy producers.

Key Words: Milk Prices, Futures, Profitability

967 The battle against high somatic cell counts: worth fighting – worth winning. A. R. Hazel* and J. K. Reineau, *University of Minnesota, St. Paul.*

In a world market where the BTSCC of most herds is required to be below 400,000, most major dairy production countries outside the U.S. average below 250,000. With a national average of 350,000 in 2002, the U.S. has increased its risk of losing share in this growing global market. Low somatic cell scores are important in every link of dairy product production, and has the potential to save the U.S. industry over 1 billion dollars every year. Low SCC is beneficial to the cow because it creates better overall health. For dairy producers, reducing mastitis levels will indirectly increase their milk price through quality premiums and create a higher level of productivity. Dairy product processors profit through higher product quality and increased yields during production. The marketing industry wins by being able to sell a product proven to have a longer shelf life. And the consumer wins with a high quality product that they can always trust to be wholesome, nutritious, and good tasting. Lowering SCC just makes sense for everyone! So how should producers go about lowering the SCC of their herd? The process is not as daunting as it first appears. First, producers need to understand the problem by culturing cows and developing a plan of attack against high SCC. Then, managers need to evaluate sanitation, especially protocols for milking procedures as well as stall and bedding management. Cow care is also important because animals need a healthy and stress-free environment to be highly productive. Last, but definitely not least, a producer must change his mindset about milking cows in order to lower SCC. This involves setting goals for SCC, developing effective protocols for management, and training everyone who milks to follow the process without fail. The U.S. dairy industry has a clear need to lower its SCC in order to compete on a world marketplace and remain a viable industry in the domestic sector. The time to do something about it is now.

968 The effects of presynchronization, in conjunction with Ovsynch, on pregnancy rate in dairy cattle. R. A. Stery* and S. C. Kelm, *University of Wisconsin, River Falls.*

The U.S. dairy industry has become increasingly competitive and many producers have responded by expanding herd sizes and striving for greater production per cow. While these adjustments have led to improved efficiency, herd reproductive performance has suffered. One of the factors associated with declining reproductive performance is reduced efficiency and accuracy in estrus detection. A proactive approach to solving this problem is the use of timed A.I. protocols. An example of a widely accepted hormonal intervention protocol is Ovsynch (50µg GnRH day 0, 25mg PGF_{2α} day 7, and 50µg GnRH day 10, followed by timed A.I. 10-24 hrs later). However, one of the drawbacks of Ovsynch is that all cows enter the protocol on the same day, regardless of their estrous cycle stage. Cows in later stages of the estrous cycle face a greater risk to fail to ovulate to the first GnRH injection and ovulate before the second GnRH injection, leading to a lower pregnancy rate to subsequent A.I. To overcome this obstacle and improve uterine health two doses of PGF_{2α} (25 mg) can be administered before initiation of Ovsynch. Presynch effectively groups cows in the early luteal phase of the estrous cycle, which has been demonstrated to be the optimal stage to start Ovsynch. Moreover, Presynch may improve uterine health by increasing the ovulation rate, luteal activity, and decreases the occurrence of pyometria. Overall presynchronization has the potential to increase the number of pregnancies per first service by 11.6 ± 3.8% 32 days after A.I. and 21.2 ± 4.3% at day 74 post A.I.

Key Words: Presynchronization, Ovsynch

969 Ionophores: Friend or foe? M. C. Scott*, *Virginia Polytechnic Institute and State University, Blacksburg.*

Ionophores are carboxylic antibiotics introduced in the late 1970s to aid in control of coccidiosis. It was also discovered that ionophores, when added to feed in small amounts, increased feed efficiency and decreased methane production in ruminants. To accomplish this ionophores alter the acetate: propionate ratio in the rumen in favor of propionate. The increased level of propionate, the main precursor for glucose, results in faster growth rates. Ionophores also have potential to increase milk production and lower occurrence of postpartum metabolic diseases in lactating cows, such as ketosis. Feeding sub-therapeutic levels of carboxylic antibiotics such as ionophores, which are not used in humans,

can prevent diseases and infections, such as coccidiosis, that would normally be treated with stronger antibiotics commonly used in human treatment. Therefore, ionophores may reduce the threat of antibiotic resistance. Ionophores are approved for use in young stock, and are currently under review for approved use in lactating cattle.

Key Words: Ionophores

970 Centralized pregnancy detection: A new option for fertility evaluation. A. Barten* and L. Fox, *Washington State University, Pullman.*

Pregnancy Specific Protein B (PSPB) can be used as a centralized pregnancy detection aid. During the third week after conception, binucleate giant cells, in the ruminant placenta produce a glycoprotein called Pregnancy Specific Protein B. This protein can be detected with an enzyme-linked immunosorbent assay (ELISA) at day 30 of gestation in multiparous cows and at day 28 of gestation in primiparous heifers. The test is 92.5% accurate for identifying pregnant cows and over 99% accurate for identifying nonpregnant cows. A blood sample is collected from

each cow and delivered to a centralized laboratory, (usually at a veterinary clinic), where the test is completed. The laboratory then prepares a report for the herd manager or veterinarian. Results are available electronically to the herd manager and/or veterinarian within 27 hours after the sample was taken. The centralized pregnancy evaluation concept provides the following advantages over traditional on-site palpation for pregnancy: 1) A high degree of quality control for assay accuracy as opposed to potentially low quality control for on-farm testing; 2) Data from multiple herds can be easily summarized; 3) Increased ability of the veterinarian and management team to compare herds with regard to application of successful programs; 4) More quality time available for the veterinarian and management team to evaluate and make improvements; 5) Reduced probability of embryonic death due to palpation and erroneous hormone use and 6) Elimination of error prone steps with data recording and transfer. PSPB can be used as a tool to improve reproductive efficiency by minimizing days open, reducing the calving interval and maintaining adequate days in milk. This approach is currently in use in the states of Washington and Idaho and will provide new options for evaluating pregnancy status in dairy cattle.

Key Words: Pregnancy Specific Protein B, Testing

Dairy Foods Undergraduate Paper Presentations

971 An industry approach to increasing the consumption of dairy products. B. Lyons*, *Louisiana State University, Baton Rouge.*

According to USDA, consumption of soft drinks has steadily increased over the past 40 years while milk consumption has decreased. The incidence of bone fractures has increased by 42%, especially among children and young adults, over the past 30 years. Researchers are concerned that many children and teenagers are not getting proper amounts of calcium in their diets. In time, the trend of less milk and more soda could lead to increased occurrences of osteoporosis. These data show that consumption of dairy foods is important to our nutritional well-being. The Food Guide Pyramid recommends consumption of 2-3 servings of dairy products/d. Milk and dairy products offer a range of well-known health benefits, the best known being calcium for proper bone health. In 1984, the Dairy Check-Off Program was implemented to provide funding for marketing, research, and educational programs. Through this program, the industry is working to increase dairy product demand and strengthen dairies image. Since the program began, dairy consumption per capita has increased 11%. Researchers across the country are finding new ways to make dairy products more appealing to young consumers through checkoff funds. Education is important to keep the importance of nutrition at the top of everyone's priorities and with the help of the Dairy checkoff, the dairy industry is able to offer nutritional information to consumers of all ages. The checkoff funds 3-A-Day of Dairy, a nutrition-based marketing and education campaign to promote healthy diets and increase demand for dairy products. The Got Milk? ads are still a big hit with consumers, and checkoff funds are continually used to feature new celebrities for promotion. Fast food restaurants are beginning to offer milk with children's meals, and this is receiving positive responses from parents. With the consumption of dairy products continuing to decline, the dairy industry must persist in efforts to promote their products. The research, marketing, and educational programs funded by the checkoff are steps in the right direction for increasing consumer awareness of the importance of dairy products for health and well-being.

Key Words: Dairy Products, Consumption, Industry Programs

972 Probiotics in dairy products- Beyond nutrition. S. Phetsomphou*, *North Carolina A&T State University, Raleigh.*

Microbial cultures have been used for thousands of years in food and food fermentations. Since the past century, there is strong evidence that the microbial cultures have the ability to prevent and cure a variety of human diseases. Probiotics are one group of these microbial cultures that are becoming increasingly popular in the United States and Europe. Although there are many different types of probiotics, the most common are *Lactobacillus bulgaricus*, *L. acidophilus*, *L. reuteri* and bifidobacteria. Dairy products such as fluid milk and yogurt are the popular food products that contain probiotic cultures. Probiotics are defined as viable microbial cultures that have positive impact on human health. A number of studies have found probiotic consumption to be useful in

the treatment of many types of diarrhea, including antibiotic-associated diarrhea in adults and young children. Several studies have shown that certain strains of probiotics, such as *L. bulgaricus* and bifidobacteria, can alleviate symptoms of lactose intolerance by providing bacterial lactase to the intestine and stomach. Probiotic consumption may also be a means for primary prevention of allergy in susceptible individuals. Studies have shown that regular consumption of probiotic could have a positive impact on cancer prevention. Animal and in vitro studies indicated that probiotic bacteria may reduce colon cancer risk by reducing the incidence and number of tumors. Functional foods including dairy food products have been known as a mean for disease prevention and the quest for optimal health at all ages. Therefore, probiotics cultures could play a big role in the human diet beyond nutritional aspects.

Key Words: Probiotics, Bifidobacteria, Dairy Products

973 On-farm milk processing. A. R Nelkie*, *North Carolina State University, Raleigh.*

On-farm milk processing plants are becoming increasingly popular as an enterprise option for dairy producers as they try to add value to their commodity of raw fluid milk. Lemajru Dairy Farm, a 100% registered, 100 cow milking herd located near West Branch, MI is being used as the experimental farm in this research model to determine if an on-farm milk processing plant is profitable. The cost of the equipment, the construction of the plant, the increased labor in the form of new employees, and the cost of operating it will be calculated. Figurative prices fabricated from local grocery stores and current on-farm processing plant are used to calculate the profit. Last year's gross income for the farm sale of raw fluid milk was around \$300,000. To build an on-farm processing plant, the income will have to cover the \$300,000 plus enough to pay for employees, loans and the cost of extra utilities needed to operate the machinery. The farm is capable of producing approximately 5000 gallons of milk each week. An estimated cost for the building and purchasing of equipment is around \$700,000 upwards to \$800,000. The endeavor has the ability to produce \$750,000 per year, making this an equitable project if family help can be obtained to work the plant thus keeping start up costs down.

974 Farmstead cheese production. K. E. Harwick*, *Pennsylvania State University, University Park.*

The farmer's share of the consumer food dollar has dropped from 46% in 1913 to 20% in 2000. A natural result has been to increase farm size, but not all producers can or want to expand. Alternatively some dairy producers have opted to produce and market value-added products such as cheese. These products produce a higher return, can open new markets, and provide brand recognition while adding variety to a farms normal operation. Consumers are willing to pay more for a value-added product, allowing for a higher quality of farm life. When deciding

whether farmstead cheese production is a good alternative to marketing wholesale milk, there are several key areas to address. Produce a high quality product, and test-market the product with family and friends before continuing. Develop a business and market research plan, be sure funding is adequate, and research food safety laws and other relevant regulations. Farmstead cheese production can be the solution to the financial constraints many small dairy producers are facing. By producing a value-added item that consumers are willing to buy at a premium, a smaller dairy can remain profitable.

Key Words: Cheese, Value-Added

975 Eliminating the calcium crisis. J. D. Woodcock*, *University of Kentucky, Lexington.*

Only 13.5 percent of girls and 36.3 percent of boys age 12 to 19 in the United States get the recommended daily amount of calcium, placing them at serious risk for osteoporosis and other bone diseases, according to statistics from the U.S. Department of Agriculture. Because nearly 90 percent of adult bone mass is established by the end of this age range, the nation's youth stand in the midst of a calcium crisis. Not only will increasing dairy intake reduce the risk for osteoporosis, but it will combat against other serious diseases and illnesses as well. One way the dairy industry is taking preventative measures is by developing new products and flavors. Flavors like chocolate, vanilla, strawberry, as well as new flavors like mocha cappuccino, orange vanilla, peaches and cream, and caramel shake have been developed and are found to be more palatable to today's youth. Researchers have also learned that by splitting the lactose enzyme, the resulting glucose and galactose can

be used to sweeten dairy products. Applying the lactase enzyme to the product will eliminate any lactose intolerance issues. Between the years of 1985 and 1997, school districts nationwide, decreased the amount of milk they bought by nearly 30 percent. It is time the school districts were held accountable for this decrease and put dairy vending machines in the hallways of the nation's schools and eliminate the national calcium crisis.

Key Words: Calcium, Crisis, Increasing Intake

976 Low-fat dairy products: Meeting the needs of a health conscious generation. L. Daubert*, *Virginia Polytechnic Institute and State University, Blacksburg.*

Consumption of low-fat dairy products has shown significant health benefits to consumers. When consumed in moderation and in conjunction with a regular exercise program, low-fat dairy products have been shown to reduce the occurrence of cancer, increase metabolism, build and maintain muscle, maintain a normal blood pressure, and decrease body fat. Conjugated Linoleic Acid, a component of milk, has been shown to both increase metabolism and to be anticarcinogenic. Other milk components including protein, calcium, phosphorus, riboflavin, and Vitamins A and D are essential for maintaining good health. Low-fat dairy products are a new trend in the health industry; as additional research becomes available about the benefits to a healthy diet, the market is predicted to increase for these specialty products.

Key Words: Low-Fat Dairy Products

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