

347 Using ear canal temperature to predict vaginal temperature. B. H. Carter*, T. H. Friend, M. A. Tomaszewski, J. R. Fisher, and G. M. Bingham, *Texas A&M University, College Station.*

The objective of this study was to evaluate the efficacy of using ear canal placement of a temperature data logger as a predictor of vaginal temperature. Temperature data loggers are commonly used to sample body temperature in unrestrained animals. Temperature loggers have previously been placed in the vagina and/or ear canal of cattle, horses and sheep. Two trials were conducted in Texas during summer (n = 7) and winter (n = 9) conditions when ambient temperature ranged from -2.0 to 9.5°C and 18.3 to 36.56°C respectively. Holstein-friesian cows were fitted with two iButton® temperature loggers programmed to sample every five min. The data loggers were placed vaginally using progesterone free CIDRs®. Data loggers were placed in the ear canal by first inserting the logger into the tip of a cotton infant sized sock

which was then filled with polyester fiber batting. The data logger portion was placed in the ear canal and the batting packed firmly against the canal opening to insulate it from external thermal influence. Finally, the pinna of the ear was wrapped around the sock and taped closed using 3 inch wide Elastikon™ tape to hold the sock and batting in place. The resulting data was analyzed using the GLM procedure of the SAS® system. Ear canal temperature predicted vaginal temperature for the summer ($r^2 = 0.58$) and for the winter ($r^2 = 0.70$) trial. To adjust for variation due to moisture cooling the data loggers during udder washes or overhead sprinkling, the data were edited to drop outlying data points. Adjusting the data yielded a correlative value of $r^2 = 0.75$ for the summer trial and $r^2 = 0.73$ for the winter trial. Measuring ear canal temperature as described can be used for predicting vaginal temperature, although ear canal temperature may be susceptible to external influences, especially water.

Key Words: Cattle, Temperature, Data Logger

Ruminant Nutrition: Nitrogen Metabolism/Immunology

348 Effects of N solubility on metabolisable protein value of grass silage. P. Huhtanen*¹, M. Rinne², and J. Nousiainen³, ¹*Cornell University, Ithaca, NY*, ²*MTT-Agrifood Research, Finland*, ³*Valio Ltd., Finland.*

Proportion of soluble N in grass silage total N (SOLN) is related to protein degradability, especially determined in situ. Hence the concentration of metabolisable protein (MP) should decrease with higher SOLN. To test this hypothesis a meta-analysis based on 253 treatment means from 79 dairy cow production studies was conducted. In each study forage treatments (e.g. date of cut, fermentation quality and wilting) were investigated. Both the level and composition of concentrates were fixed within a study. Silage SOLN was divided into ammonia N and soluble non-ammonia N (SNAN). Silage MP was calculated as amino acids absorbed from the small intestine using constant values for ruminal protein degradability and intestinal digestibility of RUP. Mixed model regression analysis (SAS) with a random study effect (intercept random) was used to model milk protein yield (MPY), efficiency of N utilisation (NU) and milk urea N (MUN) concentration using estimated MP supply alone or together with SOLN fractions as independent variables. MPY was closely related to MP supply (residual mean squared error (RSME) of MPY adjusted for random study effect 15.7 g/d) suggesting that the simple MP model estimated the variation in silage MP precisely. MPY decreased with increasing soluble N concentration in silage, but the effect was almost completely related to ammonia N, and the effects of SNAN were non-significant and small. The effects of soluble N fractions on MUN and NU were consistent with milk production responses. The lack of MPY responses to silage SNAN concentration suggested that the division of silage N between soluble and insoluble N (excluding ammonia N) does not markedly influence silage MP concentration. It is concluded that analysis of silage SOLN has a limited value in practical feed evaluation and silage MP concentration can be estimated accurately using constant values for ruminal protein degradability and intestinal digestibility of RUP.

Key Words: Dairy Cow, Protein Utilization, Degradability

349 Ruminal metabolism of ¹⁵N labelled ammonium-N and grass silage soluble non-ammonia-N. S. Ahvenjarvi*¹, A. Vanhatalo¹, P. Huhtanen¹, and A. N. Hristov², ¹*MTT Agrifood Research Finland, Jokioinen, Finland*, ²*University of Idaho, Moscow.*

Ruminal metabolism of ¹⁵N labelled ammonium-N and grass silage soluble N fractions was investigated in a change-over study using four dairy cows. Timothy grass (*Phleum pratense*) grown on a field plot was fertilized with ¹⁵N enriched ammonium-N. Grass was preserved as silage, and then fractionated into soluble and insoluble fractions. Labelled ammonium-N (821 mg of ¹⁵N in excess of background enrichment) and grass silage soluble N (840 mg ¹⁵N) was administered into the rumen as a single dose. Grass silage soluble N fractions comprised 59 mg of ammonia-¹⁵N and 781 mg of soluble non ammonia-¹⁵N (SNAN). To follow the ruminal metabolism of ¹⁵N-labelled N-fractions grab samples of ruminal digesta were collected at 0.5, 1.0, 1.5, 2, 3, 4, 6, 8, 11, 14, 17, 22, 27, 33, 39, 47, 55, 63 and 72 h after the dose. Digesta samples were treated with mercuric chloride, then fractionated into ammonia-N, SNAN, insoluble-N, and bacteria-N. Rumen liquid passage rate was determined using LiCoEDTA and particle passage rate was determined based on ADIN-¹⁵N excretion in feces. A dynamic mechanistic model was developed to describe the ruminal N metabolism. The model comprised five ruminal compartments: grass silage SNAN, ammonia-N, bacteria-N associated with non-escapable particles, bacteria-N associated with escapable particles, and liquid associated bacteria-N. The model indicated that of ammonia-N administered into the rumen 32% disappeared by absorption, 19% escaped in the liquid phase, 14% in liquid associated bacteria-N, and 36% in particle associated bacteria-N. Of grass silage soluble N 17% was absorbed as ammonia-N, 11% escaped the rumen in liquid phase as ammonia-N, 19% escaped the rumen in liquid associated bacteria, 33% in solids associated bacteria, and 19% of grass silage SNAN escaped the rumen as undegradable feed N. In conclusion, a greater proportion of silage soluble N compared with ammonia-N is incorporated into microbial N, and a considerable proportion of silage SNAN escapes rumen degradation.

Key Words: Grass Silage, Rumen N Metabolism, Modelling

350 The aerobic stability of forage maize silage preserved with microbial inoculant with and without preservatives. J. K. Margerison^{*1}, S. A. Hall², and D. Wilde³, ¹Massey University, Palmerston North, New Zealand, ²University of Plymouth, Plymouth, UK, ³Alltech Ltd, Stamford, Lincs, UK.

Forage maize (FM) was (harvested DM 29 ± 1.29 %) ensiled in experimental silos with: No additional additive and 100 ml of water / 100 kg FM (NA 0.5); No additional additive and 200 ml of water / 100 kg FM (NA 1); Sil-All fireguard at 0.25g/100kg FM (SAFS 0.5); Sil-All fireguard 0.5g/100kg FM (SAFS1); Maize All GS 0.5g/100kg FM (MAS 0.5); Maize All GS 1g/100kg FM (MAS 1). Replicate (3) silos were stored (constant 17 to 20 °C) for 30 d. On opening silage was analysed for: DM, pH, lactic acid, acetic acid, NDF, ADF, crude protein, ME and ash at 0, 24, 48, 96 and 168 h and aerobic stability (AS) was assessed. AS significantly increased in silage treated with SAFS FR and HR and MAS at FR. AS; HR (0.5) NA 29.4, SAFS 73.2, MAS 33.0, (sem 14), at FR (1) NA 41.1, SAFS 76.5, MAS 56.4, (sem 10.30). Time to maximum pH was significantly lower with additive applied at FR compared with HR, maximum pH (h); HR (0.5) 0 7.2, SAFS 7.4, MAS 6.3 (sem 0.34), FR (1), 0 7.3, SAFS 6.7, MAS 7.4 (sem 0.22). Lactic acid (g/kg DM) up to 168 hrs decreased significantly in all treatments, HR (0.5) NA -57.6, SAFS -53.3, MAS -50.7, (sem 2.01), FR (1) NA -53.2, SAFS -72.4, MAS -64.2, (sem 5.56). ME (g/Kg DM) was significantly higher at FR SAFS. ME level (g/kg DM); HR (0.5) NA 9.4, SAFS 9.4, MAS 9.5 (sem 0.03), FR (1) NA 9.4, SAFS 9.6, MAS 9.5 (sem 0.06).

Key Words: Silage, Forage Maize, Stability

351 Effect of corn hybrid and processing on ruminal and intestinal digestion using the mobile bag technique. F. W. Harrelson^{*1}, N. F. Meyer¹, G. E. Erickson¹, T. J. Klopfenstein¹, and W. A. Fithian², ¹University of Nebraska, Lincoln, ²Golden Harvest Seeds, Inc., Waterloo, NE.

Ruminal and post-ruminal DM and starch digestibility can be influenced by corn hybrid as well as processing method. An in situ trial, utilizing the mobile bag technique, was conducted to evaluate the effect of corn hybrid, processing, and interactions on ruminal and intestinal digestion. A finishing trial was conducted to evaluate feedlot performance and compare it with digestion characteristics. Two ruminally and duodenally fistulated Holstein steers (490 kg BW) were used in a 2×6 factorial design, including 2 processing methods (high-moisture, HMC, or dry-rolled corn, DRC) and 6 commercially available hybrids. Corn samples were composites from the finishing trial and were ground to simulate mastication (6.35 mm screen). Bags were ruminally incubated for 22 h; duodenal bags were then subjected to a simulated abomasal pepsin digestion prior to insertion, and collected in the feces. Significant interactions were observed between hybrid and processing method for ruminal and total-tract DM disappearance, as well as ruminal, post-ruminal, and total-tract starch digestibility ($P < 0.01$). Within processing method, post-ruminal and total tract digestibilities of starch and DM were affected by hybrid ($P < 0.05$). Ruminal starch digestion ranged from 37.5% - 42.0% for DRC and from 59.1% - 81.2% for HMC. Post-ruminal starch digestion ranged from 54.8% - 68.8% for DRC and from 78.9% - 92.8% for HMC. Total-tract starch digestion ranged from 71.6% - 81.6% for DRC and from 91.5% - 98.4% for HMC. Relationships were observed between G:F and post-ruminal starch digestibility ($r = 0.84$), as well as total-tract starch digestibility ($r = 0.73$). Correlations among hybrids within both processing methods were not significant. We conclude that processing

method has a larger impact than hybrid. HMC showed an improvement of 13.6% to 23.6% in total-tract starch digestion compared to DRC. The results of this trial suggest that hybrid as well as processing have an impact on starch digestion.

Key Words: Corn Hybrid, Corn Processing, Starch

352 Ruminal L-dopa degradability and in vitro fermentation kinetics of *Mucuna pruriens* and soybean meal treated with or without L-dopa. S. K. Chikagwa-Malunga^{*}, A. T. Adesogan, S. C. Kim, N. J. Szabo, R. C. Littell, and N. Krueger, *University of Florida, Gainesville.*

Mucuna pruriens (velvet bean) is an underexploited protein supplement because mucuna L-dopa causes adverse symptoms in non-ruminants but not ruminants. To understand ruminant tolerance of L-dopa, the kinetics of ruminal fermentation of mucuna seeds (M), M L-dopa, and soybean meal treated without (SB) or with 13.8% of DM of L-dopa (SBD) were measured. Ground (1 mm) samples of M (4.89% L-dopa), and SB (Experiment 1) or SB and SBD (Experiment 2) were fermented in triplicate in buffered rumen fluid in culture bottles and headspace gas pressure was measured hourly for 24 h. Each experiment was repeated once. A non-linear exponential model was fitted to the data. Furthermore, SBD and M were fermented in triplicate for 0, 4, 8, 16, and 24 h and residual L-dopa concentration was measured. Fermentation of M vs. SB produced more ($P < 0.01$) total gas (255 vs. 97 ml/g DM), but required a longer ($P < 0.01$) lag phase (3.53 vs. 1.38 h). Fermentation of M vs. SB produced more ($P < 0.05$) total VFA (203 vs. 180 mmol/L) and butyrate (20.0 vs. 14.5 molar %), less acetate (34.7 vs. 42.9 molar %; $P < 0.10$, tendency), and a lower acetate:propionate ratio (1.35 vs. 1.87; $P < 0.05$). Addition of L-dopa to SB increased ($P < 0.01$) total gas production (85.3 vs. 173.9 ml/g DM), total VFA concentration (132 vs. 188 mmol/L) and molar % of butyrate (13.6 vs. 27.1) and isobutyrate (7.5 vs. 8.2; $P < 0.10$, tendency), but reduced ($P < 0.05$) the fermentation rate (0.09 vs. 0.07 ml/h). The concentration of L-dopa in fermented M and SBD decreased by 53 and 47%, respectively. In conclusion, M was more extensively fermented than SB, and degradation of L-dopa by ruminal microbes was confirmed. Adding L-dopa to SB did not impair ruminal fermentation.

Key Words: Mucuna L-dopa, Soybean Meal, Gas Production

353 Study internal molecular-structural changes of flaxseeds affected by dry roasting at various conditions in relation to rumen degradation kinetics of dairy cattle. K. Doiron^{*} and P. Yu, *University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this study was to reveal internal molecular-structural changes of flaxseed (cv. Vimy) affected by dry roasting at the temperature of 120°C for 20 (T1), 40 (T2) and 60 min (T3), respectively, in relation to rumen degradation kinetics in dairy cattle. The internal structural changes of roasted flaxseeds were determined by global-sourced FTIR spectroscopy in the mid-IR region from 4000 to 400 cm⁻¹ and were analysed using Cluster (CLA) and principal component analysis (PCA). The rate and extent of rumen degradation of the raw (T0) and roasted flaxseeds (T1, T2, and T3) was determined using in situ nylon bag technique. The hypothesis of this study was that the roasting changes the flaxseed inherent structures and rumen degradation kinetics. The results showed that dry roasting did not affect

Kd of DM and EE with average of 7.04 and 19.77%/h, respectively ($P > 0.05$), but decreased ($P < 0.05$) Kd of CP from 7.20 to 5.54%/h. Dry roasting reduced ($P < 0.05$) ED of DM and CP from 571 to 532, and 139 to 109 g/kg DM, respectively without affecting ED of EE with average of 215 g/kg. With the FTIR spectroscopy and CLA and PCA spectral analyses, the internal molecular-structural changes were revealed. The results showed that in the fingerprint region (1800-800 cm^{-1}), protein amides (1715-1485 cm^{-1}) and carbohydrate region (1200-800 cm^{-1}), the cluster of the raw (T0) and roasted flaxseed (T3) were significantly different, indicated the internal structures were different between the raw and roasted flaxseed. The roasting affected both protein region and carbohydrate region. Further study is needed to understand the relationship between internal molecular structural changes and nutrient availability in ruminants.

Key Words: Molecular Structure, Raw and Roasted Flaxseeds, Nutrient Availability

354 Microbial characteristics, microbial nitrogen flow, and urinary purine derivative excretion in steers fed at two levels of intake. G. I. Crawford*, M. K. Luebke, J. R. Benton, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln*.

Ruminally and duodenally fistulated Holstein steers (569 ± 40 kg) were fed at two levels of intake to determine purine:N ratio of ruminal microbes, endogenous purine derivative (PD) contribution to urinary PD excretion, the effect of spot sampling time on ratios of urinary PD to creatinine (PD:C), and the relationship between urinary PD excretion and duodenal purine flow. Steers were arranged in a crossover design and were fed 40 or 85% of their previously determined individual ad-libitum DMI of a diet consisting of 70% high-moisture corn, 20% corn bran, 5% alfalfa hay, and 5% dry supplement. The diet was provided by automatic feeders in equal portions delivered every 4 h. On average, steers consumed 5.3 and 11.3 kg DM/d with the 40 and 85% intake levels, respectively. Microbial purine:N ratio (g:g) did not differ ($P = 0.59$) between intake levels, and ranged from 0.127 to 0.251 with an overall average of 0.205. Urinary PD:C and microbial CP (MCP) flow estimated from duodenal purine flow were both greater ($P < 0.05$) with the 85% intake level than the 40% intake level. Microbial efficiency, measured as either g of CP/kg OM truly digested ($P = 0.08$) or g of CP/kg TDN intake ($P = 0.05$), increased with the 85% intake level compared with the 40% intake level. Urinary PD excretion (mmol) was related ($P < 0.05$; $r^2 = 0.603$) to duodenal purine flow (mmol), and resulted in an equation of $0.412 \times + 57.774$. This implies a 41.2% recovery of absorbed purines and an endogenous PD contribution of $501 \mu\text{mol/kg BW}^{0.75}$. Diurnal variation in urinary PD:C ratio was not evident ($P = 0.86$) when diets were fed in six evenly spaced and equal portions/d. Results from this experiment suggest that microbial purine:N ratio is not affected by level of feed intake, and that urine spot samples may be used to estimate relative differences in MCP flow, although low recoveries of duodenal purines may occur.

Key Words: Microbial Protein, Purine Derivatives, Steers

355 The incidence of liver abscessation in pasture based bull beef systems of New Zealand. J. Gibbs*, J. Laporte-Urbe, C. Trotter, and J. Noel, *Dairy Science Group, Agriculture and Life Sciences, Lincoln University, Canterbury, New Zealand*.

Bull beef systems for manufacturing grade beef in New Zealand (NZ) account for almost 50% of the national beef output. Dairy calves comprise approximately 85% of bulls, with suckled beef breeds the remainder. From weaning stock are almost entirely pasture fed until target slaughter carcass weight (CW) 240-270 kg at 18-24m. This has led to intensified grazing management in the last decade. Liver abscessation in cattle is usually associated with cereal feeding systems, and was traditionally uncommon in pasture based NZ livestock, but anecdotal industry reports of slaughter bulls and clinical cases in dairy cows suggest the incidence is sharply increasing. There is no existing research on liver abscessation in NZ. This project sought to establish the mean, breed and seasonal incidences and CW effect of liver abscesses at slaughter in NZ bulls. A large commercial database of source farm, breed, CW, liver abscess scores (absent, mild, moderate or severe) from all bulls slaughtered in that operation between 2000 and 2005 was analysed. The mean incidence of abscessation over all years was 10% (range: 9-13%), and increased across the years studied. The incidence increased each month across spring and summer and declined in autumn and winter. There was great variation in incidence between farms (range: 2-45%). Dairy breeds had a twofold greater mean incidence (9.3%) compared to beef breeds (4.6%), with Friesians the highest at 11.2%. Severe grade comprised 66% of all abscess cases. In each year, the range of mean CW for each liver grade group was < 20 kg, and mean CW was lowest in the severe grade, greater for absent grade, and highest for mild or moderate grades. Conclusions: Liver abscess incidence at slaughter appears to be increasing in NZ beef bulls, and is at similar levels to grain fed cattle systems internationally. Dairy breeds have a higher incidence, and there is a reduction in CW only with severe grade. Concurrent research in NZ suggesting the traditional understanding of rumen function in pasture fed cattle is inadequate for contemporary high intake dairy cows on high quality pastures under intensive management may help explain these findings.

Key Words: Liver Abscess, Dairy Beef

356 Metaphylaxis therapy interacts with temperament to influence performance of growing beef steers. Z. D. Paddock*¹, J. E. Sawyer¹, G. E. Carstens¹, R. R. Gomez¹, B. M. Bourg¹, D. K. Lunt², S. A. Moore³, and D. S. DeLaney³, ¹Texas A&M University, College Station, ²Texas A&M University, McGregor, ³King Ranch, Kingsville, TX.

The effects of metaphylactic therapy on growth, intake, and feeding behavior traits were evaluated using 119 Santa Gertrudis steers (initial BW 265 ± 24 kg). Steers were preconditioned at the source of origin, transported 550 km, and allowed to rest overnight before processing. At processing, steers were weighed, blocked by weight, and randomly assigned within weight block to receive 1.5 mL/45.5 kg BW ceftiofur crystalline free acid (EXC) administered at the base of the ear, or to receive no antimicrobial (CON). Steers within blocks receiving both treatments resided in common pens. Mean exit velocity (EV) was measured on d 0 and 28, as rate of distance traveled exiting from a chute, and used as an objective measure of temperament. Steers were weighed on d 0, 14, and 28. Meal frequency, duration, and DMI were recorded continuously using a GrowSafe feeding system. Data were analyzed as a mixed model with block as a random effect, treatment as a fixed effect, and EV as a covariate. An unequal slopes model was fit for treatment by EV interactions, with treatment differences tested at the mean EV and at ± 1 SD. Meal frequency increased with EV for EXC steers, but was unaffected by EV in CON steers ($P = 0.02$). Meal

duration was similar for steers with low EV, but decreased at a greater rate for CON than EXC steers ($P = 0.01$); at high EV, EXC steers had greater meal duration. Intake declined with increasing EV in CON steers, but was unaffected by EV in EXC steers ($P = 0.01$). High EV steers treated with EXC consumed more feed than high EV steers that were untreated. Interactions between EV and metaphylaxis resulted in differences in ADG from d 0 to 14 ($P < 0.01$) and d 0 to 28 ($P = 0.01$). At low EV, ADG was similar among treatments, but at mean or high EV, steers treated with EXC had greater ADG, and treatment differences increased with EV. Only one steer was clinically morbid during this trial. Results demonstrate that metaphylaxis therapy resulted in positive effects on ADG, DMI and feeding behavior during the receiving period for steers with high EV, whereas, metaphylaxis therapy had less utility for steers with low EV.

Key Words: Metaphylaxis, Temperament, Morbidity

357 Effects of *Mannheimia haemolytica* challenge on blood flow and net splanchnic flux of amino acids in fed or fasted steers. L. O. Burciaga-Robles^{*1}, C. R. Krehbiel¹, D. L. Step², C. A. Loest⁴, L. Chen⁴, M. Montelongo², A. W. Confer², J. N. Gilliam², B. P. Holland¹, and C. L. Goad³, ¹Department of Animal Science, ²Department of Health and Veterinary Sciences, ³Department of Statistics, Oklahoma State University, Stillwater, OK, ⁴Department of Animal and Range Sciences, New Mexico State University, Las Cruces, NM.

This experiment evaluated blood flow and net splanchnic flux of AA during a bovine respiratory disease (BRD) challenge. Twenty two steers (BW = 320±24 kg) with chronic catheters to measure blood flow and net flux across the portal drained viscera (PDV) and liver were used. Arterial, portal, and hepatic blood samples were collected at 1.5-h intervals on d 0, 1, 2, and 3. Treatments (2×2 factorial arrangement) applied to steers were: 1) ad libitum feeding and not challenged (FED/CON); 2) ad libitum feeding and challenged (d 0) with *M. haemolytica* via a tracheal tube (FED/CH); 3) 72-h fasting and not challenged (FAST/CON); 4) 72-h fasting and challenged (FAST/CH). All data were analyzed using repeated measures and first-order autoregressive covariance structure. Diet affected ($P < 0.05$) portal, hepatic, and arterial blood flow, which were greater for FED compared with FAST steers (461, 708, and 170 vs 427, 522, and 97 L/h, respectively). Challenge increased haptoglobin concentration, and was greater for FAST/CH than FAST/CON steers (Diet×Challenge; $P = 0.004$). Concentration of total AA was greater ($P = 0.01$; 1,966 vs. 1,645 μM) in CON than in CH steers. In addition, there was a net removal of total AA (-117.8 mmol/h) by liver of CH and a net release for CON steers (21.5 mmol/h; $P = 0.03$). Although arterial concentrations of essential AA were not different ($P = 0.22$), CH tended ($P = 0.11$) to have a greater net removal (-65.2 vs. -22.3 mmol/h) of essential AA by the liver than CON steers. Nonessential AA concentration was greater ($P = 0.001$) for CON (1,173 μM) vs. CH (924 μM) steers. Similar to total AA, there was a net removal of nonessential AA (-52.8 mmol/h) by the liver for CH and a net release for CON steers (42.5 mmol/L; $P = 0.02$). These results suggest that BRD increases removal of AA by the liver of steers, potentially in support of an acute phase response.

Key Words: *Mannheimia Haemolytica*, Amino Acids, Steers

358 Effects of endotoxin and dietary protein on N metabolism, and serum cortisol and haptoglobin in growing beef steers. J. W. Waggoner*, C. A. Loest, J. L. Turner, C. P. Mathis, K. K. Kane, D. M. Hallford, and M. K. Petersen, New Mexico State University, Las Cruces.

Bacterial lipopolysaccharide (LPS) stimulates the immune system and mimics metabolic responses of gram(-) bacterial infection in cattle. Effects of LPS and dietary protein on N metabolism and serum concentrations of cortisol and haptoglobin (HAPT) in 24 steers (250 ± 2.8 kg BW) were studied. Treatments were a 2 × 3 factorial of LPS (0 vs 1.5 μg/kg BW; -LPS vs +LPS) and diets containing (DM basis): 1) 14.5% CP, 11.6% DIP and 2.9% UIP (CP14.5CON); 2) 16% CP, 13.3% DIP and 2.7% UIP (CP16DIP); and 3) 16% CP, 11.3% DIP and 4.7% UIP (CP16UIP). Source of DIP was casein and sources of UIP were fish meal and corn gluten meal. Steers were adapted to diets (±1.2 Mcal/kg NE_g; DM fed = 1.8% BW) for 14 d, and were infused (i.v. 1 mL/min) with LPS (in 100 mL saline) on d 15. Blood samples were collected before LPS infusion and every 2 h for 12 h thereafter. Feces, urine, and orts were collected for 5 d starting d 16 and composited. Serum cortisol and HAPT increased ($P \leq 0.05$) in response to +LPS, but were not affected by diet. Serum cortisol of +LPS steers increased at 2 h, peaked at 4 h (5.4 vs 75.6 ng/mL for -LPS vs +LPS), and remained elevated for 12 h ($P \leq 0.05$); serum HAPT of +LPS steers were elevated at 4, 6, 10, and 12 h ($P \leq 0.05$). Dietary DM and N intakes were lower ($P \leq 0.05$) for +LPS vs -LPS steers, and N intakes were greater ($P \leq 0.05$) for higher CP diets. There was a LPS × diet interaction ($P = 0.06$) for N retained (% of intake); diet did not alter N retention of -LPS steers, but +LPS steers retained more N when fed CP16DIP and CP16UIP than CP14.5CON. These results imply that growing steers exposed to endotoxin may require greater dietary protein concentrations to offset altered intake and metabolic demand.

Table 1.

Nitrogen, g/d	-LPS			+LPS			SEM
	CP14.5-CON	CP16-DIP	CP16-UIP	CP14.5-CON	CP16-DIP	CP16-UIP	
Intake ^{a,b}	104	118	116	98	107	110	2.7
Feces	36	39	36	33	30	36	2.6
Urine ^c	42	53	49	52	52	50	2.8
Retained ^{a,b}	26	26	31	13	25	24	3.1
N Retention, % intake ^{a,c}	25	22	27	13	23	22	2.7

^aLPS effect ($P \leq 0.05$).

^bDiet effect ($P \leq 0.05$).

^cLPS × Diet effect ($P \leq 0.10$).

Key Words: Stress, Protein, Cattle

359 Effect of dietary boron on the immune function of growing steers. R. S. Fry*, K. E. Lloyd, S. K. Jacobi, and J. W. Spears, North Carolina State University, Raleigh.

An experiment was conducted to determine the effects of dietary boron (B) on the performance and immune response of growing steers. Thirty-six Angus and Angus-cross steers (average initial BW 270

kg) were blocked by weight within breed and randomly assigned to treatments. Treatments consisted of: 1) control (no supplemental B), 2) 5 mg/kg of supplemental B, 3) 50 mg/kg of supplemental B. Supplemental B was supplied from sodium borate. The control diet contained 10.2 mg/kg of B. Steers were housed in slotted floor pens with 2 animals per pen. Weights were taken at 14 d intervals. Jugular blood was obtained from steers on either d 42 or 44 for assessment of lymphocyte blastogenesis. One-half of the steers in each treatment group were sampled on each date. Supplemental B tended ($P = 0.12$) to increase the blastogenic response of B lymphocytes to pokeweed mitogen, but did not affect proliferation of T lymphocytes when stimulated with concanavalin A or phytohaemagglutinin (PHA). Humoral immunity was assessed on d 49 by injecting steers IM with a

pig red blood cell (PRBC) suspension. Blood samples were collected at d 0, 7, 14, and 21 following PRBC administration for determination of antibody titers. Specific anti-PRBC IgG titers were affected by a treatment \times day interaction ($P < 0.07$). Boron supplemented steers had greater ($P < 0.05$) IgG titers than controls on d 7 but not on d 14 or 21 post-injection. Cell-mediated immune response was also evaluated following an intradermal injection of PHA on d 77 of the study. Skinfold thickness following PHA injection was not affected by dietary B. Performance of steers during the 77 d study was not affected by dietary B. Results of this study indicate that supplemental B did not affect the performance of growing steers, but may affect the immune response.

Key Words: Cattle, Boron, Immunity

Ruminant Nutrition: Opportunities to Improve Forage Utilization and Rumen Function

360 Utilizing fats and carbohydrates in forage-based diets for lactating cows. M. S. Allen*, *Michigan State University, East Lansing.*

Forages contain relatively high concentrations of fiber that is slowly and incompletely digested, limiting energy intake for high producing cows. Therefore, cows with high energy requirements are fed forage-based diets supplemented with feeds containing readily digested carbohydrates and (or) fats. However, specific fuels can have physiological effects that alter intake and utilization of dietary energy. The profile and pattern of absorption of fuels depend on the composition of the diet, including not only its chemical composition, but physical characteristics which influence ruminal fermentation and dynamics. Rapidly fermented carbohydrates and some fat sources can decrease feed intake, ruminal fiber digestibility, efficiency of microbial protein production, and increase flow of intermediates from fatty acid biohydrogenation from the rumen. Physiological effects of specific fuels might involve alteration of hormone or enzyme concentrations affecting gluconeogenesis, lipolysis and lipogenesis in tissues, fat and protein production by the mammary gland, gut motility, or feeding behavior. These physiological effects can influence energy intake, yield of milk and milk components, and body condition independent of the energy contributed by the fuel itself. Furthermore, physiological and production responses to specific fuels are dependent upon animal characteristics (e.g. glucose demand, lipolytic state, adiposity). Therefore, physiological effects of energy concentrates must be considered when formulating diets rather than formulating for energy density alone. The objective of this presentation is to discuss physiological effects of specific fuels and how these effects can be utilized to optimize diets for cows in different stages of lactation.

Key Words: Feed Intake, Energy Partitioning, Physiological State

361 The role of ionophores in improving utilization of forage and forage-based diets. V. Fellner*, *North Carolina State University, Raleigh.*

Ionophores have been routinely added to non-lactating ruminant diets to improve animal performance and efficiency of feed utilization. Although several ionophores have received FDA approval, the most common and widely studied ionophore is monensin that is now also approved for use in lactating cow rations. Benefits of ionophores are

attributed, almost exclusively, to changes that occur in the rumen. A shift in the ruminal acetate:propionate ratio, with a concomitant decrease in methane and ammonia, are classical responses to feeding ionophores. The magnitude of change can vary, however, and is not always predictable. Preferential binding of ionophores to specific ions, level of ionophore inclusion in the diet, and dietary composition are some of the reported factors contributing to the variability in ionophore action. Managing the diet is perhaps the most critical factor in maximizing the benefit of ionophores, irrespective of type or level of inclusion. With high forage diets a lower dose of ionophore elicits maximal ruminal response. This is in contrast to high concentrate diets that typically provide for a greater ionophore response at higher doses. Generally, the fiber digesting microbes are most sensitive to ionophores whereas starch fermenters tend to be more resistant. Yet, a decrease in nutrient digestibility, specifically fiber, is more pronounced in diets having low, rather than high forage content. Changing the forage:concentrate ratio alters several factors, including intakes, passage rates and pH, all of which impact microbial shifts. Among the predominant fibrolytic bacteria, some that may even be resistant to ionophores, there is considerable difference in kinetics of microbial growth in response to ionophores. The major starch utilizing bacteria are less sensitive to ionophores but seem to alter their metabolism with source and level of starch. The driving force in ruminant production is energy whether it's from grain or forage. Varying dietary ingredients varies the substrate for the microbes as well as ruminal kinetics, both of which interact to determine the response to ionophores.

Key Words: Ionophore, Forage, Rumen

362 Lactating dairy cow responses to yeast products. P. H. Robinson*¹ and L. J. Erasmus², ¹*University of California, Davis,* ²*University of Pretoria, Pretoria, South Africa.*

Studies with lactating Holstein cows, from peer review publications, were used to determine responses to feeding *Saccharomyces cerevisiae* yeast products (YP) from diet composition. The 21 studies reflected 6 YP, with 3 used in 6, and 3 used in 1 study. In spite of differences (i.e. NDF/starch; $P < 0.05$) in diets, and milk yield, milk energy output and milk fat % ($P < 0.05$) among control group cows (CGC) in studies of the 3 major YP, proportional milk, milk component, milk energy and DMI responses of cows to these YP did not differ. Thus all 21 studies were pooled and simple correlations showed that higher diet NDF or