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. Charmley[3], and J. Duynisveld[3], [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. Greene[1], N. A. Cole[2], and F. T. McCollum, III[1], [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 caseinte infusion on voluntary feed intake and digestive function in steer calves fed a Sudangrass-based growing diet. E. G. Alvarez*[1] and R. A. Zinn[2], [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 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.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 postruminally 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. Postruminal 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 (R2 = .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. McCuistion, 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-fed liquid supplement on performance of beef cows grazing tallgrass-prairie range. D. A. Llewellyn*[1], B. T. Gray[1], T. T. Marston[1], and C. A. Bandyk[2], [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. Manella[1], C. Boin[2], G. F. Alleoni[1], J. J. A. A. Demarchi[1], 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 feed 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 altered (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 degradabilties 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. Lee[1], J. S. Eun[2], Y. K. Kim[3], J. P. Cant[4], and Y. H. Moon*[5], [1]*National Livestock Research Institute, Suwon, Kyonggi, Korea,* [2]*Samyang Feed Company, Suwon, Kyonggi, Korea,* [3]*Chungnam National University, Taejon, Chung Nam, Korea,* [4]*University of Guelph, Guelph, ON, Canada,* [5]*RAIRC, 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 μM on 0.5, 1.0 and 1.5 M propionate, respectively, compared to 168 μM 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. Michal[1], J. J. Ramsey[2], K. A. Ross[1], D. E. Johnson*[3], and K. A. Johnson*[1], [1]*Washington State University, Pullman,* [2]*University of California, Davis,* [3]*Colorado 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 O_2 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 *perioplum* 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 colostral 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 $\pm$ 75.47 grams and for calves fed in the afternoon were 455.01 $\pm$ 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 $\pm$ 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

[1]Fishers 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. Eun[1], S. C. Lee[2], Y. K. Kim[3], and Y. H. Moon*[4], [1]*Samyang Feed Company, Suwon, Kyonggi, Korea,* [2]*National Livestock Research Institute, Suwon, Kyonggi, Korea,* [3]*Chungnam National University, Taijon, Chung Nam, Korea,* [4]*RAIRC, 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 Duncans 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 Glucose	Phase 1 NEFA	Phase 1 Insulin	Phase 2 Glucose	Phase 2 NEFA	Phase 2 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
Longissiumus 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 ($R^2 = 0.585$), PRC ($R^2 = 0.030$), MARB ($R^2 = 0.028$), Live YG ($R^2 = 0.017$), and GeneSTAR Marbling Test ($R^2 = 0.011$) indicating that RTU was the only major contributor. Approximately 17% of the variation in average dressed price was explained by RTU QG ($R^2 = 0.148$) and MARB ($R^2 = 0.025$). 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. Sniffen[2], [1]*Clemson University, Clemson, SC,* [2]*Holderness, 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 postruminal 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. Kawamura[2], K. Tajima[1], M. Mitsumori[1], and A. Takenaka[1], [1]*National Institute of Livestock and Grassland Science, Tsukuba, Ibaraki, Japan,* [2]*Tsukuba 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 Autonoma 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 Autonoma 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 at 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 proteineous 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 cellulolylic 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. Castillejos[1], S. Calsamiglia*[1], A. Ferret[1], and R. Losa[2], [1]*Universitat Autonoma de Barcelona, Spain,* [2]*AKZONOBEL/CRINA SA, Cland, 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 (39C), 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. Busquet[1], S. Calsamiglia*[1], A. Ferret[1], and C. Kamel[2], [1]*Universitat Autonoma de Barcelona, Bellaterra, Spain,* [2]*University 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 (fenugreek = 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. Devant[1], A. Bach*[1], and J. A. García[3], [1]*IRTA-Unitat de Remugants, Barcelona, Spain,* [2]*ICREA, Barcelona, Spain,* [3]*IRTA-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 NH3-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 NH3-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-^{13}C-acetone for 0 or 8 hours and analyzed via gas chromatography and mass spectroscopy. There was neglible ^{13}C-isopropanol in the 0-hour incubates. In the 8-hour incubates, the isopropanol ^{13}C-atom percent averaged 32.5% ± 0.68% (SE). The average transfer quotient (TQ = 100 x atom percent of isopropanol/acetone) was 98.6% ± 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. Clark[1], and D. E. Freeman[2], [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 nonamonnia N (SBM = 467, ESBM = 514, NSBM = 564, and WRSB = 498) was higher ($P < .05$) for NSBM and that of nonamonnia 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 nonamonnia 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 ± 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 premixes (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 premixes. 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. Schroeder[1], M. W. Chichlowski[2], M. L. Bauer[1], and S. A. Soto-Navarro[1], [1]*North Dakota State University, Fargo,* [2]*North Carolina State University, Raleign.*

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 Autonoma 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 170C 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 the12 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 pruiriens*, 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 x 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 Filho[2], J. Zervoudakis[1], A. Souza[1], and E. Detmann[3], [1]*Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa, DZER-FAMEV/UFMT, Cuiabá-MT, Brazil,* [2]*Universidade Federal de Viçosa Av. P.H. Rolphs, Viçosa-MG, Brazil,* [3]*Universidade 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 canulated 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 analized 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 analized 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-Majee[1], R. D. Shaver[1], D. Sapienza*[2], J. G. Coors[3], J. G. Lauer[3], and C. Venhaus[2], [1]*Dairy Science Dept., University of Wisconsin, Madison,* [2]*Pioneer Hi-Bred Int'l Inc., Johnston, IA,* [3]*Agronomy 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 (RSTARCHD) 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-Majee[1], R. D. Shaver*[1], J. G. Coors[2], D. Sapienza[3], J. G. Lauer[2], and C. Venhaus[3], [1]*Dairy Science Dept., University of Wisconsin, Madison,* [2]*Agronomy Dept., University of Wisconsin, Madison,* [3]*Pioneer 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; $\frac{1}{2}$ 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. Meilahn[2], [1]*Agland, Inc., Eaton, CO,* [2]*Weld 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 100oC for 24 h or 65oC 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±.73 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 (r2 = 6.2%). Gelatinized starch content decreased with increasing flake density and fines score (P<0.001) but was highly variable (r2 = 15.5%). The regression equation was: gelatinized starch lb/ton of flaked grain (DMb) = 1145 - 61 .3(fines score) - 11.9(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. Broderick[2], [1]*University of Wisconsin, Madison,* [2]*U.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 ^{15}N. After 4 and 8 h of incubation, samples were taken to obtain total solid pellets, supernatants, and isolated bacterial pellets. Supernatants were analyzed for NH_3, total AA, and VFA. Total solid and bacterial pellets were analyzed for DM, total N and ^{15}N 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 NH_3 and total AA concentrations. As expected, NH_3 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.

		Forage				
Item	AS	AS:CS	CS	SE	P>F	
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	
		CP, % of DM				
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-Anon[2], [1]*Sage Biosciences Inc., Lethbridge, AB, Canada,* [2]*Novus 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. Supplementation 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. Noftsger*, 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. Luimes[1], L. E. Wright[3], C. A. Toerien[1], and J. P. Cant[1], [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 (**NH_4-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 NH_4-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 NH_4-N averaged 17.8 ppm (± 0.8 ppm) and there was little variation across farms ranging from 16.5 to 19.1 ppm. Milk NH_4-N was correlated with the analyzed CP% of the diet ($P < 0.05$; $R^2 = 0.35$) 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 NH_4-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 NH_4-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 NH_4-N was not correlated with measured dietary soluble protein (1170 ± 180g; $P > 0.10$). With the current data, milk NH_4-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. Lapierre[2], L. E. Phillip[1], P. W. Jardon[3], and R. Berthiaume[2], [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/cm ^{2}) placed in N-free polyester bags (pore size 50 μm) 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≤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≤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≤0.05) for SE (91.4%) compared to EP (89.5%) but lower (P≤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≤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. Rathburn[3], and J. C. Woodworth[4], [1]*Department of Animal Science, Tarleton State University, Stephenville, TX,* [2]*Texas Agriculture Experiment Station, Stephenville, TX,* [3]*Department of Biology, Tarleton State University, Stephenville, TX,* [4]*Lonza 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 μmol/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 μmol/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. Kitts[1], N. B. Kristensen[1], K. R. McLeod[1], D. E. Axe[2], and D. L. Harmon[1], [1]*University of Kentucky, Lexington,* [2]*IMC 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 mesentereic 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, VI[2], S. L. Owens[1], and B. J. Bequette[1], [1]*Department of Animal and Avian Sciences, University of Maryland, College Park,* [2]*Bovine 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), [^{15}N]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-^{15}N into Ala, citrulline, Arg, and urea (nmol / 10^6 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 ^{15}N^{15}N-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 $^{15}N^{15}N$ and $^{15}N^{14}N$-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 $^{15}N^{15}N$-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±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, 15N, 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. McKinnon[1], C. R. Christensen[2,3], and D. A. Christensen[1], [1]*College of Agriculture, University of Saskatchewan, Saskatoon, SK, Canada,* [2]*Canadian Light Source, Saskatoon, SK, Canada,* [3]*Western 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 peaked 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 quantitites 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. Noziere[1], C. Richard[2], B. Graulet[2], D. Durand[1], D. Remond[1], and J.C. Robert*[2], [1]*INRA URH, Clermont-Ferrand Theix, Fance,* [2]*ADISSEO 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 5^{th} 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 × 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 ≠ 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.

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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.

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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 ± 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 (1022g ± 51.4 vs 765g ± 61.4; P = 0.03) in nutrient restricted when compared to control fed ewes while there was no change in abomasal weight (215g ± 20.1 vs 211g ± 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.

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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.

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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 < 0,02) 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 Jünior[1], M. N. Pereira*[1], H. Boer[2], and S. Tamminga[2], [1]*Universidade Federal de Lavras, Lavras, Brazil,* [2]*Wageningen 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 ^{13}C labeled VFA. The exponential decay rate of the $^{13}C/^{12}C$ ratio after pulse dosing ^{13}C-Acetate, ^{13}C-Propionate or ^{13}C-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 ^{13}C 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 ^{13}C-Valerate was similar to that obtained with unlabeled valerate by the HVal-Co technique. There was no increase in ^{13}C enrichment of rumen microbes four hours after intraruminal infusion of ^{13}C-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. Freitas[1], and A. C. Queiroz[1,2], [1]*Universidade Federal de Viçosa-DZO, Viçosa, MG, Brazil,* [2]*CNPq, Brasilia, 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 bellow.

DMI = −100 + (0.116*BW) + (2.91*Milk) + (22.8*%Fat) − (2.6%*%Fat^2) − (0.00483*BW*Milk); R^2 = 0.91; Eq.1

Milk = −24.4 + (0.0227*BW) + (0.891*DMI) − (0.232*%NDF) + (0.412*%TDN); R^2 = 0.95; Eq.2

Milk = 36.1 − (0.364*%NDF); R^2 = 0.59; Eq.3

%CP = −49.9 + (0.429*BW) − (35.4*%Fat) + (20.9*%Ptn) + (4.4*%Fat^2) − (3.18*%Ptn^2) − (0.000445*BW^2); R^2 = 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], [1]*Universidade Federal de Viçosa-DZO, Viçosa, MG, Brazil,* [2]*CNPq, Brasilia, 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. Multiparious cows (n=8) averaging 84.50±10.34 days in milk and 36.10±4.46 milk yield were used in a 4×4 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 Liñeiro, 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 NH_3N 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. Broderick[2], [1]*University of Wisconsin, Madison,* [2]*U.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 ^{15}N. 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.

	CP, % DM							
Item	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. Wildeus[1], K. E. Turner*[2], and J. R. Collins[1], [1]*Virginia State University, Petersburg,* [2]*USDA, 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 F_2 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. Huber[2], A. C. Calderon[3], and H. G. Garcia[3], [1] *Universidad de Sonora, México,* [2] *University of Arizona, Tucson,* [3] *Universidad 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. Aguilera[1], R. Daetz[1], F. Wittwer[1], and P. Orellana[2], [1] *Fac. Cs. Veterinarias, Universidad Austral de Chile, Valdiva, Chile,* [2] *Depto. 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. Fourty 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