

RUMINANT NUTRITION

1119 Nutrient balance across regions of the United States. C. J. Nelson*, *University of Missouri-Columbia*.

Soils and their parent materials are the primary providers of minerals for plant growth. Soils differ geographically depending on how they developed, and are classified by the Natural Resources Conservation Service into major land resource areas (MLRAs). These MLRAs are affected by climate and agronomic cultural practices which alter erosion and weathering to release minerals. Root growth and organic matter recycling mineralize nutrients and plants concentrate them in herbage. Forage and grassland species are adapted to distinct areas depending on soils and climates, and tend to buffer some of the mineral imbalances from the soil. Legumes are generally higher in phosphorus, potassium, and calcium than are cool-season grasses, but bioavailability of the minerals differs among species. Warm-season grasses are generally lower in minerals than are cool-season grasses. Leaves are usually higher in concentration than stems. Animal production systems depend on the plants and the nutrients they contain, and return minerals from urine and feces to the soil, but the spatial patterns of urine and feces distribution are not the same as the spatial patterns of original intake. Thus, the mineral availability at a specific location gradually changes with time. Federal and local legislation affect management strategies for effective nutrient balance mainly through regulations involving surface and groundwater quality. The regulatory concept of a "closed system" based on a grazing area, farm, ranch, or watershed has been considered in which annual input-output nutrient balances are calculated. Solutions and recommendations on managing mineral resources through livestock production systems will require cooperation among agronomists, animal scientists, economists, and systems analysts.

Key Words: Forage Quality, Environmental Quality, Mineral Cycling

1120 History and limitations of research data to accurately quantify mineral element balance in dairy and beef cattle. D. K. Beede, *Michigan State University, East Lansing*.

Historically, feeding recommendations for mineral elements have been set to maximize animal growth rate, milk yield, and support pregnancy. Less regard has been given to amount of the element excreted. Minimizing element excretion and enhancing utilization by cattle will be more important as specific nutrient management legislation is enacted. Mineral elements most often mentioned or considered in the context of manure nutrient management include P, K, Ca, Se, Cu, and Zn. Objectives of this presentation are: 1) to explore and summarize limitations and variability of historical research data (e.g., element concentrations within and among feeds, estimates of bioavailability, utilization, and excretion) and indicate where data are lacking; 2) to examine factors which may influence and cause variable excretion (e.g., varying intake of elements and differing requirements of animals); 3) to compare estimates and expressions of excretion used in current standards for nutrient management planning (e.g., American Society of Agricultural Engineers, 1993. Manure Production and Characteristics. ASAE Stand. D. 384.1) and to determine if historical data are adequate, given current and potential future productivity of cattle; and, 4) to suggest specific areas for future research to improve accuracy of mineral element balance data for use in whole farm nutrient management planning and development of legislation. Phosphorus will be the working example to illustrate fundamental concepts.

Key Words: Cattle, Minerals, Bioavailability

1121 Animal grouping strategies, sources of variation and economic factors affecting nutrient balance on dairy farms. N. R. St-Pierre*, *The Ohio State University, Columbus, OH*.

Growing environmental concerns are forcing animal industries to re-evaluate current feeding practices and their relationship to nutrient excretion. Management practices affect the optimum level of nutrients to be fed and the resulting nutrient excretion. Our objectives are (1) to quantify how grouping strategies on dairy farms affect nutrient balance and optimum allocation of nutrient inputs, (2) to derive a procedure for transforming nutrient requirement functions of individual animals into response functions of groups of animals, (3) to determine how uncertainty in level of inputs, model structure and parameter estimates influence the optimum allocation of inputs, and (4) to evaluate the sensitivity of the economic optimum to the cost of nutrient excretion. The economic optimization must integrate measures of cropping efficiency, managerial efficiency and animal efficiency. Additionally, the system is dynamic and residual carryover effects must be explicitly accounted for in the analysis. A proper objective function has to be identified and selected so that reduction in nutrient excretion is not accomplished at the expense of total national food production.

Key Words: Nutrient Balance, Animal Grouping

1122 Nutrient management on farms in The Netherlands. A. Kuipers*, *Research Station for Cattle, Sheep and Horse Husbandry (PR), Lelystad, The Netherlands*.

In the European Union groundwater should contain less than 50 mg nitrate/l. With respect to phosphorus (P) individual countries have developed alternative strategies.

In The Netherlands emphasis is placed both on P and on N. In addition to the European guideline for nitrate, ammonia volatilization (emission) should be reduced by 50–70%. Regulations limit the amount of manure (expressed in P) applied per ha.

A more balanced P-supply to the land has been achieved by transport of manure from surplus to deficit regions. In experiments lowering the P-contents in concentrates and mineral supplements reduced P-losses without adverse effect on production. Also lower P-requirements for cattle are examined. N-losses in dairy farming can mainly be reduced by adapting the farm operation. Several management practices were studied with the PR-farm-model to assess their contribution to the mineral losses. A combination of a more efficient use of fertilizer N, restricted grazing in combination with a more balanced ration, and to a less extent, a higher milk production per cow resulted in considerable reductions in nitrate leaching. Application of slurry by injection techniques diminishes the ammonia volatilization at farm-level by almost 50%. Other techniques, such as low emission housing and covering of slurry storages, have relatively high costs. In practice, slurry application by injection has become obligatory, only allowed in the growing season.

Urea content in bulk milk is a new tool in managing N-losses. Starting in 1998 cattle farmers have to keep record of the nutrients. On basis of the nutrient balance sheet a tax will be imposed on surpluses of N and P. Part of the dairy farmers have already several years experience with the nutrient balance as integrated management tool.

Key Words: Nutrient Management, N and P, Dairy Farming

1123 Effect of amount and source of protein supplemented to grazing dairy cows on ruminal fermentation and in situ crude protein degradation characteristics. F. Bargo* and D. H. Rearte, *Fac. Cs. Agrarias. UNMdP - EEA INTA Balcarce, Argentina.*

Six Holstein cows ruminally cannulated were used in a double 3 x 3 Latin square with 15 day-periods to study the effect of different protein supplementations to grazing cows on ruminal fermentation and in situ CP degradation characteristics. Sunflower meal (SM) and feather meal (FM) were used as high and low rumen degradability protein sources, respectively. Treatments consisted of three different concentrates: low CP - SM (L-SM), high CP - SM (H-SM), and high CP - FM (H-FM). All cows grazed a winter oats pasture (*Avena sativa* L.) with 2310 DM kg/ha availability, 14.2% CP, 33.6% NDF and 82.2% in vitro DM digestibility for 8 wk. L-SM, H-SM and H-FM concentrates had 15.3%, 23.3% and 24.6% CP, respectively. Contrasts were L vs H and SM vs FM. Total DMI, estimated using Cr₂O₃ as a fecal marker, was similar among treatments ($P > 0.05$). Neither pH nor total VFA concentration in ruminal fluid were affected by treatments ($P > 0.05$). Both L-SM and H-FM presented lower NH₃-N ruminal concentration than H-SM ($P < 0.05$). Ruminal digestion characteristics were estimated using the model of Orskov and McDonald (1979). Amount of protein supplemented did not modify ruminal digestion fractions of concentrate CP ($P > 0.05$), but a source of low rumen degradability decreased degradable fraction, degradation rate and effective degradability of CP (EDCP) ($P < 0.05$).

Item	L-SM	H-SM	H-Fm	SEM	L vs H, $P <$	SM vs FM, $P <$
pH	5.5	5.5	5.5	0.02	0.83	0.47
NH ₃ -N, mg/dl	21.1	28.5	19.3	1.67	0.04	0.05
VFA, mmol/L	129.2	133.9	127.6	3.89	0.44	0.45
Concentrate CP						
Soluble, %	39.7	40.8	42.4	4.1	0.86	0.69
Degradable, %	53.6	55.4	38.6	4.9	0.80	0.05
Rate, %/h	8.6	10.9	5.1	1.6	0.26	0.002
EDCP (kp ¹ = 7%/h)	68.8	74.5	58.4	2.3	0.16	0.01

¹rate of passage assumed

1124 Effects of protein concentration and source on nutrient digestibility and rumen characteristics of steers limit-fed high-concentrate diets. L. J. Driedger*, S. C. Loerch, and J. P. Schoonmaker, *The Ohio State University, OARDC, Wooster.*

Five ruminally fistulated Holstein steers (average BW 691 ± 23 kg) were used in a 5 X 5 Latin square experiment to examine effects of CP concentration and source on nutrient digestibility, and rumen characteristics of steers limit-fed high-concentrate diets. A basal whole shelled corn diet (9% CP) was fed at restricted DMI (1.5% of BW). Steers were fed supplements to achieve either 14 or 11% CP in total diet DM. For each CP concentration, CP source came from either soybean meal (SBM; 14% SBM or 11% SBM) or a combination of SBM and urea (U), in which SBM made up 50% and U made up 50% of supplemental CP (14% U or 11% U). The fifth treatment was run as a negative control (NC) to the other 4 treatments; no supplemental CP was added to the basal whole shelled corn diet. All diets were formulated to provide equal daily intakes of NE_m, vitamins, and minerals. Dry matter and OM digestibilities were 7% greater ($p < .07$) for steers fed the SBM diets compared to those fed the U diets, indicating that U may not be an adequate source of CP for limit-fed diets. Nitrogen source and concentration did not affect apparent N digestibility ($p > .10$ and $p > .44$, respectively); however, apparent N digestibility for steers fed the NC diet was 30% lower ($p < .01$) than all other diets. There were no differences among steers fed any of the diets for rumen fluid liquid dilution rate ($p > .74$), rumen pH ($p > .15$), or VFA concentration ($p > .30$). In situ DM disappearance of ground corn was 8% greater ($p < .06$) for steers fed 14% CP diets compared to 11% CP diets, and was lowest ($p < .01$) for steers fed the NC diet. Total tract DM and OM digestibilities were not affected by CP concentration, indicating that CP concentration may have affected site of digestion, but not extent of digestion. This suggests that CP requirements may be met at lower concentrations when whole shelled corn-based diets are limit-fed.

Key Words: Limit-feeding, CP Concentration, CP Source

1125 Evaluation of a corn specific enzyme preparation for dairy cattle in Northwestern Mexico. R. Gómez¹, F. Ysunza*², and B. Rodríguez¹, ¹Patronato del Centro de Investigaciones Pecuarías del Estado de Sonora, A.C., ²Centro de Investigación en Alimentación y Desarrollo, A.C., México.

A feeding trial was conducted to evaluate the effects of treatment of ground corn with a commercial enzyme preparation with amylase and protease activities, upon voluntary feed intake and milk production of Holstein cattle in Sonora, Mexico. Twenty four animals (12 second to fifth lactation cows and 12 first lactation heifers), with average of 165 days in milk (149 to 207 range), were confined in two pens with electronic gates for individual feed control and measurement. Six cows and six heifers were randomly assigned to one of two treatment groups. Animals were fed alfalfa hay and an 18% protein concentrate in which the corn was either untreated or treated with the enzyme preparation at a dose of 200 ml per 1000 kg in a sprayed solution. All animals were previously adapted for 30 d to facilities, management and feeding. Offered feed and refusals were recorded daily, as well as milk production from each animal milked twice a day for a period of 96 d between April and July. Voluntary daily dry matter intake did not differ, averaging 20.31 kg and 19.83 kg for the untreated and the treated groups, respectively. Average daily milk production for the untreated group was 24.4 kg vs 23.4 kg for the treated group, with no effect found due to the use of the enzyme preparation. Based on the conditions of this trial, specific amylase and protease in this commercial preparation seem to exert no effects on intake and milk production of Holsteins, despite the expected positive effects on ruminal digestibility and availability of starch.

Key Words: Corn, Enzymes, Milk Production

1126 Effect of replacing corn silage with orange peel silage on milk yield, milk composition and ruminal fermentation characteristics of dairy cows. L. C. V. Ítavo*¹, G. T. Santos¹, C. C. Jobim¹, H. V. Petit², P. G. Dias⁴, J. C. Damasceno¹, and R. P. Pelliza³, ¹Universidade Estadual de Maringá/DZO - Maringá - PR - Brazil, ²Agriculture and Agri-Food Canada, Lennoxville, QC, Canada, ³Bolsista de I.C./CNPq, ⁴Bolsita de Aperfeiçoamento/CNPq, *Bolsista do CNPq - Brasília - DF - Brazil.

The objective of the experiment was to study the effects of replacing corn silage with orange peel silage on production of the dairy cow. Four lactating intact dairy cows were used in a 4 x 4 Latin square design to study the effects of dietary treatments on milk yield and milk composition, and four rumen fistulated dairy cows were used in a second 4 x 4 Latin square to determine the effects on ruminal fermentation. The four treatments consisted of 0, 25, 50 or 75% orange peel silage replacing corn silage in the TMR diets. All diets were isonitrogenous and isoenergetic. Orange peel was ensiled in two 50-tonne silos at the Experimental Farm of Iguatemi, PR. Ruminal pH and ammonia N averaged 6.6 and 8.9 mg/100 ml of rumen fluid, respectively, and were similar ($P > .05$) among treatments. Orange peel levels had no effect ($P > .05$) on DMI, milk yield, 4% FCM yield, milk percentages of fat, protein, and lactose. These data suggest that orange peel silage is a good replacement for corn silage to decrease production costs in countries where it is available.

Key Words: Orange Peel Silage, Dairy Cow, Milk Yield

1127 The effects of graded levels of clinoptilolites on the performance and fermentation of feedlot steers consuming a high concentrate diet. K. J. Sanders* and C. R. Richardson, *Texas Tech University, Lubbock.*

One hundred and twenty cross bred steers were utilized in a completely randomized design experiment to determine the effects of graded levels of clinoptilolites on DMI, ADG, feed efficiency (FE), dry matter digestibility (DMD), ammonia release (AR) and ruminal pH. Clinoptilolites were included at 0 (control), 2, 4 and 8 % of the basal finishing diets. Diets were formulated to be isonitrogenous at 13% CP. Dry matter digestibility was determined by the Moore modification of the Tilley and Terry procedure (1970). Fermentation media was incubated for 4, 8, 16 and 24h. Dry matter intake was greatest ($P < .05$) for 8 and 2% (10.2 and 9.7 kg/d) with the 4% being the lowest (9.3 kg/d). No differences were detected for ADG, but 2% exhibited the highest numerical ADG (1.6 kg/d) followed by the 0% (1.58 kg/d). The 4% treatment had the lowest (1.52 kg/d). The 0% steers had the best FE (2.7) while 8% had the worst (2.9). At 4h, 8% had the highest DMD (27.8%) but was only different ($P < .05$) from 4% (20.7%). However, at 24h, 2% had the greatest DMD (55.7%) and was different ($P < .05$) from 4% (50.7%). At 4h, 0% had the lowest ($P < .05$) AR (18.31 mg/dL) and 2% had the highest (27.2 mg/dL) but, at 16h, 2% was the lowest (22.1 mg/dL). The 4% had the highest AR (26.6 mg/dL) and differed ($P < .05$) from 0 and 2%. After 24h, the 4% had the lowest AR (23.5 mg/dL) and the 0 and 8% were higher ($P < .05$) AR (27.5 and 27.21 mg/dL, respectively). Ruminal pH was higher for the treated media but only the 4% differed ($P < .05$) from the 0% (5.55) at 4h of incubation. At 8h, the 2% had the lowest pH (6.21) with the 8 and 0% being higher (6.31 and 6.21, respectively). The pH was higher for the treated media but only the 8% differed. After 24h, the 4% had the highest pH (5.54) and was different from 2% which had the lowest pH (5.36). These data suggest that clinoptilolites can be included at 2% in high concentrate feedlot diets without having adverse effects on the performance or digestion.

Key Words: Clinoptilolite, Performance, Digestibility

1128 Effects of an exogenous microbial enzyme preparation (Fibrozyme) on ruminal digestion of fescue hay. J. M. Tricarico*¹, K. A. Dawson¹, and K. E. Newman², ¹*University of Kentucky, Lexington*, ²*Alltech Biotechnology Center, Nicholasville, KY.*

A series of studies examined the effects of a microbial enzyme preparation (Fibrozyme, Alltech Biotechnology Center, Nicholasville, KY) on the digestive processes associated with ruminal microbial populations from animals fed fescue hay-based diets. This enzyme preparation contained fermentation extracts of *Aspergillus niger* and *Trichoderma viride* and was formulated to contain a minimum of 100 U of xylanase activity/g. The preparation increased the rate of fiber solubilization (reducing sugars released) from ground fescue hay by 8% during a short incubation period (<15 min) when added to a buffered incubation system in the absence of ruminal microorganisms. Fibrozyme addition (1 mg/g of feed) to batch cultures of ruminal microorganisms harvested from an animal receiving an unsupplemented diet and provided with 0.5 g of ground fescue hay enhanced *in vitro* dry matter disappearance (44 vs. 51%, $P < 0.1$) and hexose utilization rates (1.88 vs. 1.96 mmoles/L/h, $P < 0.1$) after 12 h of incubation, but not after 18 h of incubation (52 vs. 54%; 2.16 vs. 2.11 mmoles/L/h, respectively). *In vitro* dry matter disappearance (IVDMD) was greater ($P < 0.05$) in 12-h batch cultures established with rumen fluid from animals receiving a hay-based (100% grass hay) diet supplement with Fibrozyme (26%, $n = 12$) than those observed in cultures established with rumen fluid from animals fed a similar unsupplemented diet (38%). Fibrozyme had no effect ($P > 0.1$) on hexose utilization rates by microbial populations from these animals (1.55 vs. 1.37 mmoles/L/h, respectively). In contrast, Fibrozyme supplementation of a 50% concentrate diet did not alter IVDMD but enhanced the rates of hexose utilization in batch cultures (1.96 vs. 1.66 mmoles/L/h). These observations suggest that Fibrozyme supplementation can enhance the solubilization of fibrous substrates in a way that can significantly influence the activities of microbial populations in the rumen.

Key Words: Ruminants, Digestion, Enzyme Supplements

1129 An evaluation of bloat control agents for feedlot cattle. F. H. Van Herk*^{1,2}, T. A. McAllister¹, J. J. McKinnon², and A. N. Hristov¹, ¹*Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB*, ²*University of Saskatchewan, Saskatoon, SK.*

The effects of salinomycin (13 ppm, S), monensin (26 ppm, M), S + dioctyl sodium sulfosuccinate (10.7 L tonne⁻¹, SDSS) and S + BloatGuardTM (2.25 kg tonne⁻¹, SBG) on feedlot bloat and ruminal fermentation were investigated in a double 5 × 5 Latin square experiment involving five ruminally cannulated Jersey steers (square 1) and five ruminally cannulated Angus heifers (square 2). The cattle were given *ad libitum* access to a bloat-provoking pelleted diet containing (as-fed) 50% canola screenings, 30% barley grain and 20% dehydrated alfalfa, fed daily at 0800 h. The control diet (C) contained no antimicrobial agents. In each period, experimental diets were fed for 18 d, then the cattle were returned to a bloat-safe barley silage-based diet for 10 d. The cattle were observed at 0800 h and 1100 h every second day, and bloat was scored subjectively on a 5-point scale (1 = no froth, no distension; to 5 = extensive froth, distension of left and right flanks). Ruminal fluid samples were collected at 0800 h and 1100 h every second day and every 2 h over the last 24 h of each period. Bloat scores were highest (2.5 to 3.5) after 8 d on each of the bloat-provoking diets and tended to decline thereafter. Bloat scores on d 9 were higher ($P < .05$) for cattle fed SBG than for those fed C, but bloat scores did not differ among treatments ($P > .05$) at any other time. In samples collected at 1100 h, concentrations of reducing sugars, ammonia and total free amino acids (TFAA) in ruminal fluid tended to increase ($P < .10$) as cattle were adapted to the bloat-provoking diets, but these values did not differ among treatments ($P > .10$). Occurrence of high TFAA concentrations did appear to coincide with periods of most severe bloat. In this study, bloat was induced experimentally by diet manipulation to ensure its occurrence. None of the products tested was effective for eliminating bloat induced under these conditions, however the etiology of the bloat induced in this manner may not be representative of that occurring with lower frequency in cattle fed the 90% barley grain/10% barley silage diets typically used in feedlots in western Canada.

Key Words: Feedlot Cattle, Bloat, Ionophore

1130 Populations of individual species of ruminal cellulolytic bacteria in cows fed high and low fiber diets based on corn silage or alfalfa silage. P. J. Weimer*¹, C. L. Odt¹, G. M. Waghorn², and D. R. Mertens¹, ¹*USDA, Agricultural Research Service, Madison, WI*, ²*AgResearch Grasslands, Palmerston North (N.Z.).*

Few direct measurements have been made of the populations of individual species of fibrolytic bacteria in the rumen. The purpose of this study was to determine if individual fibrolytic species were differentially affected by diet. Four cows were used in a balanced 4X4 Latin square design with factorial arrangement of treatments (2 fiber sources and 2 fiber levels). Diets containing alfalfa silage or corn silage with either 24 or 32% aNDF (using sodium sulfite and amylase) were fed at 12 h intervals during 4-week periods. After dietary adaptation (23 d), the relative population sizes of *Fibrobacter succinogenes*, *Ruminococcus flavefaciens* and *Ruminococcus albus* were determined from ruminal samples collected 3 h post-feeding over 3-5 feeding cycles. Population sizes were determined using oligonucleotide probes to species-specific 16S ribosomal RNAs, and were calculated as a fraction of total bacterial RNA. *Ruminococcus albus* was the most abundant of the three species, accounting for up to 3% of the bacterial population. The other two species each typically accounted for <1% of the bacterial population. Relationships among cow, diet, and microbial population were obscured somewhat by the inherently high variability of the RNA probe method. However, analysis of variance revealed that the effects of diet on the populations were not significant ($p < 0.05$), while differences among cows were noted for some populations. The relative population size of each species displayed weak positive correlations with one other. Moreover, the relative population of each species displayed negative correlations with ruminal pH measured 3h after feeding, but positive correlations with dry matter intake, milk production, and milk protein. The data suggest that populations of these three fibrolytic species respond co-ordinately, and that population levels of individual species are more dependent on cow than on diet.

Key Words: Rumen, Fiber Digestion, Bacteria

1131 Influence of saponins on fatty acid digestion in steers fed a high-fat finishing diet. J. E. Ramirez*, E. G. Alvarez, W. Chai, M. F. Montano, and R. A. Zinn, *University of California, El Centro*.

Four Holstein steer calves (168 kg) with cannulas in the rumen and proximal duodenum were used in a 4 W 4 Latin square experiment to study the effects of sarsaponin supplementation on characteristics of digestion. The basal diet contained 67% steam-flaked corn, 4% alfalfa, 8% sudangrass, 3.5% cottonseed meal, 6% cane molasses and 8% yellow grease. Treatments consisted of the basal diet plus 0, 250, 500 or 750 mg/kg (DM basis) sarsaponin (added to the basal diet at time of feeding). Sarsaponin supplementation did not affect ($P > .10$) ruminal, post-ruminal and total digestion of OM, N, starch, NDF, fatty acids or ruminal microbial efficiency. Numbers of protozoa, ruminal pH and total VFA molar proportions were not affected ($P > .10$) by sarsaponin level. Ruminal concentration of acetate, isovalerate, and acetate:propionate ratio increased (linear component, $P < 0.05$) with increasing level of sarsaponin supplementation. Ruminal concentration of propionate (linear component, $P < 0.10$) decreased with increasing levels of sarsaponin in the diet.

Key Words: Saponins, Fat, Metabolism

1132 Performance of Holstein heifers on fresh sugarcane as the only dietary forage. M. A. F. Andrade and M. N. Pereira*, *Federal University of Lavras, Brazil*.

Sugarcane is a high-producing, low-cost forage under tropical environments. Despite its high sucrose content, the fiber fraction is of low quality and may limit the performance of dairy animals. We completely replaced corn silage NDF with finely ground sugarcane NDF in 35-factorialized with two protein levels (12 or 16 heifers were individually fed for a 8-week comparison period following a 3-week standardization period in a covariate adjusted, randomized block design. Heifer age at the beginning of the comparison period was 413 ± 96 days (mean \pm SD). Statistical analysis was performed using the repeated measures approach of the MIXED procedure of SAS. Main effect of forage source is shown as there was no significant interaction or protein level effect ($P > .10$).

Trait	Sugarcane	Corn Silage	SEM	P value
Body weight (kg)	308.4	301.8	1.4	<.01
Heart girth (cm)	150.5	148.8	0.3	<.01
Height at withers (cm)	120.2	119.8	0.3	.39
Dry matter intake (kg/d)	8.7	8.2	0.2	.09
Dry matter intake (% of BW)	2.88	2.74	0.07	.16
Body weight gain (kg/d)	1.18	1.01	0.04	.01
Chewing time (min/d)	693.8	812.0	18.6	<.001
Chewing time (min/kg DMI)	87.7	108.5	4.0	<.01

Ground sugarcane NDF at 35% of diet dry matter resulted in improved performance, lower chewing activity and similar dry matter intake compared to diets with equal content of corn silage NDF. Sugarcane is a viable alternative for raising dairy replacements.

Key Words: Heifers, Sugarcane, Protein

1133 Effect of substituting neutral detergent soluble fiber for non-structural carbohydrates on fermentation by ruminal microorganisms in continuous culture. P. Ariza-Nieto*¹, M. D. Stern¹, A. Bach¹, and M. B. Hall², ¹*Department of Animal Science, University of Minnesota, St. Paul*, ²*Dairy and Poultry Sciences, University of Florida, Gainesville*.

Eight dual flow continuous culture fermenters were used to evaluate the effect of neutral detergent soluble fiber (NDSF) or non-structural carbohydrates (NSC) on fermentation by ruminal microorganisms. Citrus pulp and hominy were added to a basal diet as sources of NDSF (pectin) or NSC (starch), respectively. The basal diet contained 26.7% corn silage, 6.0% alfalfa hay and 3.8% cottonseed hulls on a dry matter (DM) basis. The diet high in citrus pulp (citrus pulp diet) contained (in DM basis) 15.6% crude protein (CP), 34.7% neutral detergent fiber (NDF), 18% NDSF and 12.7% NSC, whereas the diet high in hominy (hominy diet) contained 16.6% CP, 33.2% NDF, 9.4% NDSF and 25.4% NSC. Organic matter, DM, NDF and acid detergent fiber digestion were not affected ($P > .05$) by treatments. Ammonia nitrogen concentration was greater ($P < .05$) for the hominy diet (14.2 mg/100mL) than for the citrus pulp diet (9.0 mg/100mL). Ammonia nitrogen flow followed the same trend. This was probably due to the greater CP content and the numerically greater CP degradation observed with the hominy diet (59.7%) compared with the citrus pulp diet (51.1%). It is also possible that ammonia nitrogen uptake by microbes was greater with the citrus pulp diet. Total nitrogen, non-ammonia nitrogen, microbial nitrogen and dietary nitrogen flows were not affected by treatments. However, efficiency of microbial protein synthesis was greater ($P < .05$) for the citrus pulp diet than for the hominy diet (29.3 vs 26.1 g bacterial nitrogen/kg organic matter truly digested). Possible reasons for this response are lower maintenance requirements for fiber-digesting microbes, or the tendency for NSC-digesting microbes to store starch. Results suggest that NDSF and NSC can provide similar sources of energy for ruminal microbes.

Key Words: Fiber, Protein, Digestion

1134 Effect of particle size on the effectiveness of fiber in alfalfa silage. P. W. Clark*¹ and L. E. Armentano*², ¹*University of Wisconsin-River Falls*, ²*University of Wisconsin-Madison*.

The objective was to determine the influence of alfalfa silage particle length on milk yield, milk composition and chewing activity. Multiparous lactating Holsteins were used in feeding trials based on 4×4 Latin squares with 21 d periods. Sixteen animals were used in each of two years providing two repetitions. All four diets (dry basis) contained a basal level of 10.5% NDF from corn silage and 2.5% NDF from chopped alfalfa/grass hay which was the only forage in the low fiber control (CONT) diet. The other diets contained an additional 10% NDF from either coarse alfalfa silage (CALF), finely rechopped alfalfa silage (FALF) or a 50/50 mix of each (MALF).

Combined years forage particle size information

Coarse Alfalfa Silage	Fine Alfalfa Silage	Mixed Alfalfa Silage	Corn Silage	Hay
(mean particle size (cm))				
.72	.54	.63	.93	.41

Combined years intake, milk and rumination data

	CALF	MALF	FALF	CONT	SE
DM Intake (kg/d)	23.8	23.4	23.9	24.0	.33
Milk (kg/d) ^{a,b}	35.2	35.9	36.2	37.9	.32
Fat% ^a	3.46	3.46	3.48	2.91	.04
Protein% ^a	3.17	3.14	3.14	3.25	.01
Rumination (min/d) ^{a,b}	455	416	402	413	10
Total chew (min/d) ^{a,b}	700	660	630	638	12

^a Contrast between CONT and CALF is significantly different ($P < .05$)

^b Linear relationship between CALF, MALF and FALF ($P < .05$)

There were no year by treatment interactions or quadratic effects. Reducing alfalfa silage particle length/increased milk yield and reduced chewing time yet had little effect on dry matter intake, or milk composition.

Key Words: Alfalfa Haylage, Fiber, Particle Size

1135 Kinetic of solid fraction and characterization of particle size on the ruminal content and feces of sheep fed with basal oat straw diet. H. G. González*², O. B. Ruiz¹, L. C. De la Vega¹, H. C. Hernández³, A. M. Pérez², A. E. Orozco¹, and J. C. Carrillo², ¹Universidad Autónoma de Chihuahua, ²Universidad Autónoma de Baja California, ³Universidad Autónoma de Baja California Sur, México.

Eight crossbred sheep with permanent ruminal cannulated were used in a fed trial. The objective was to evaluate the effect of two size ground length: 2.5 cm (T1) and 10 cm (T2) of forage on the ruminal kinetic of the solid fraction and to characterize the particles ratio into the ruminal content and feces. The animals were fed by using a basal oat straw diet and to providing them an alfalfa hay supplement (20%). To the kinetic of solid fraction a two-compartment model was used. To determine the size of particle the sieving wet technique was used. The analysis of data was made by using a crossover design. The feed intake was *ad libitum*. It was observed a bigger dry matter intake ($P < .07$) of T1 than T2 (56.8 vs 50.4 kg⁻¹W^{.75}). The slow constant rate (K_1) showed higher by-pass velocity ($P < .05$) in T1 than T2 (3.01 vs 2.5%h⁻¹). Nevertheless, the fastly constant rate (K_2) was no significant ($P > .05$) between treatments (5.3 vs 5.6%h⁻¹), such as on the mean retention time (51.9 vs 55.2h), respectively. A non significant differences ($P > .05$) were found in the percentage of particle size in the ruminal content nither on feces in animals by using sieve 1.18mm (7.9 vs 7.4; .8 vs .6), .5mm (8.5 vs 7.4; 1.5 vs 1.5), .3mm (22.7 vs 22.6; 14 vs 13.4), .15mm (28.6 vs 29.8; 39.8 vs 41.2) and at the soluble (32.2 vs 32.8; 41.7 vs 43.3), such as in fineness module (2.33 vs 2.28; 1.78 vs 1.74) and uniformity module (0:4:6 vs 0:4:6; 0:2:8 vs 0:2:8) between T1 and T2, respectively.

Key Words: Sheep, Kinetics, Particle Size

1136 Voluntary feed intake and kinetics in steers fed with a basal oat straw diet and supplemented with alfalfa hay. H. C. Hernández*², H. G. Ferreira¹, L. C. De la Vega¹, A. C. Correa³, A. M. Pérez³, and H. G. González³, ¹Universidad Autónoma de Chihuahua, ²Universidad Autónoma de Baja California Sur, ³Universidad Autónoma de Baja California, México.

To evaluate the digestive performance, four Hereford steers 230 kg and permanent ruminal cannulated were fed to a basal oat straw diet and supplemented with alfalfa hay to levels (0, 10, 20 and 30%) of dry matter intake and .5 kg rolled milo per animal d⁻¹, all diets were isonitrogenous. The data were analyzed by using a 4 X 4 latin square. The kinetics of solids was adjusted by using a two-compartment model. The voluntary intake of straw (57.3, 59.9, 62.3 and 72.6 g kg⁻¹W^{.75}) and total diet (64.6, 69.8, 80.7 and 81.1 g kg^{.75}) was improved ($P < .01$) proportional to an increase in the supplements levels. The constant slow rate (K_1) showed values of 1.6, 2, 2.2 and 2.3 % h⁻¹, the constant fast rate (K_2) values were 4.2, 3.45, 2 and 1.75% h⁻¹ to the supplemented levels 0, 10, 20 and 30% respectively. A higher by-pass transit velocity ($P < .01$) of solid material through the whole digestive tract was observed proportional to an increase in the supplement levels. However, non differences ($P > .05$) were found to liquids kinetics. The ruminal volume was: 81.6, 83.7, 84.9 and 69.9 L, the dilution rate was: 7.4, 10.6, 8.1 and 6.7% h⁻¹, the flow rate was: 8.6, 5.5, 5.8 and 5.6 L h⁻¹ and the rechange rate was: 2.7, 1.8, 1.8 and 2.5 times d⁻¹ to the supplemented levels: 0, 10, 20 and 30% respectively. The alfalfa hay supplementation improved the basal diet intake by increasing the dynamic of solid fraction in the animal.

Key Words: Steers, Voluntary Intake, Kinetics

1137 Cumulative gas production of alfalfa forage treated with different cell wall-degrading enzymes. A. D. Iwaasa^{1*}, L. M. Rode¹, K. A. Beauchemin¹, and S. Eivemark¹, *Research Centre, Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada.*

The objective of this research was to determine if fibrolytic enzyme supplementation increases the digestibility of alfalfa forage using the gas production (GP) technique. Aqueous solutions of fibrolytic enzyme mixtures (A, B, and C) with similar pectinase activity (apple juice clarifying units) were sprayed onto ground (1 mm) alfalfa hay. Enzyme mixtures were applied at four levels (g/g of forage DM): 0 (CONTROL), 1 (A1, B1, and C1), 2 (A2, B2, and C2), and 4 (A4, B4, and C4). Gas production was recorded at intervals from 0.5 to 48 h. Volatile fatty acid concentrations (VFAs) were determined at the end of fermentation. After 2 h of incubation, all enzyme treatments had higher ($P < 0.05$) GP than CONTROL. Higher ($P < 0.05$) GP was found for enzyme C compared to A and B during the first 12 h of incubation at all levels. Gas production for enzyme A and B was similar during the first 12 h of incubation; however, after 12 h the GP for A was higher ($P < 0.05$) than B and C at all levels. Enzyme treatments resulted in higher acetic acid (A), propionic acid (P) and total VFAs compared to the CONTROL for all levels. The A:P ratios for all enzyme treatments were lower ($P < 0.05$) compared to CONTROL at all levels. Results indicate that addition of feed enzymes increased total VFAs and GP. Measuring GP is a useful method of screening enzyme mixtures as potential feed additives for ruminants. Although the enzymes were similar in terms of pectinase activity, their side activities likely accounted for the differences in GP profiles observed among enzymes. As enzyme preparations are often complex mixtures of activities, it is difficult to predict efficacy from main activities alone.

Key Words: Gas production, Fibrolytic enzyme, Alfalfa

1138 Effects of sodium lasalocid and roughage/concentrate ratio on ruminal fermentation in lactating dairy cows. P. H. M. Rodrigues*, C. S. Lucci, L. F. Laranja da Fonseca, L. Melotti, and F. R. Lima, *University of São Paulo Faculdade de Medicina Veterinária e Zootecnia Pirassununga, São Paulo, Brazil.*

The effects of sodium lasalocid and different roughage:concentrate ratios were studied in a 4 x 4 latin square design experiment, with four caulated heifers (500kg body weight). Treatments were applied in a 2 x 2 factorial arrangement of two levels (40% or 70%) of roughage (Coast Cross hay) and two levels of lasalocid/animal/day (zero or 200mg) as follow a) 40-: 40% roughage without lasalocid, b) 40+: 40% roughage with lasalocid, c) 70-: 70% roughage without lasalocid and c) 70+: 70% roughage with lasalocid. Rumen fluid samples were collected at the twentieth first day of each experimental sub-period at 0h, 1h, 2h, 3h, 4h, 6h and 8 hours after first meal and analyzed for pH, ammonia-nitrogen (NH3-N) and volatile fatty acids (VFA) concentrations (mM/L). Statistical analyses tested the main effects of lasalocid (Las) and roughage:concentrate ratios (Ratio), as well as the interaction (LasxRat) effect. Increasing roughage in the diet resulted in increased NH3-N concentration (mg/dl), and molar percentage of acetate (C₂), and acetate:propionate ratio (C₂/C₃) and lowered molar percentage of propionate (C₃). Addition of lasalocid did not affect these parameters regardless of the diet. Neither the addition of lasalocid, nor the roughage:concentrate ratio affected pH, butyrate (C₄) and total VFA concentration (Total).

Var	40 -	40 +	70 -	70 +	C.V.	Las	Ratio	LasxRat
PH	6.2	6.0	6.3	6.3	6.1	NS	NS	NS
NH3-N	8.2	10.5	14.2	13.7	52.4	NS	<.01	NS
C2	63.8	64.1	71.4	71.0	7.4	NS	<.01	NS
C3	26.1	25.4	18.8	19.3	23.0	NS	<.05	NS
C4	10.1	10.6	9.9	9.7	14.7	NS	NS	NS
C2/C3	2.6	2.7	3.8	3.7	23.4	NS	<.01	NS
Total	93.8	96.4	92.3	89.8	17.2	NS	NS	NS

C.V. = Coefficient of variation. Las, Ratio and LasxRat = Statistical probabilities of different effects.

Key Words: Ionophores, Ruminal Fermentation, Dairy Cattle

1139 Degradation of fluorescent lignin-model compounds by ruminal microbes. H. Kajikawa^{*1}, H. Kudo¹, T. Kondo², M. Kuwahara³, and T. Watanabe³, ¹Nat. Inst. Anim. Ind., Tsukuba, ²Tohoku Nat. Agric. Exp. Station, Morioka, ³Wood Res. Inst., Kyoto Univ. (Japan).

Lignin-carbohydrate complexes (LCCs) restrict the utilization of plant cell walls by ruminants. However, degradation of LCCs into smaller fragments (i.e. oligomers) has been found to occur in the rumen. The objective of this study was to evaluate the ruminal activities of cleaving benzyl ether bonds, which are normally found in grass LCCs, by using lignin model compounds which emit fluorescence by benzyl ether bond cleavage. Two low molecular lignin models, 4-methylumbelliferone veratryl ether (VAU, dimer), and non-phenolic β -O-4 lignin model compound incorporating 4-methylumbelliferone by benzyl ether linkage (GGU-ET, trimer) were chemically synthesized. A coniferyl dehydrogenation polymer bearing fluorescent β -O-4 benzyl ether model (F-DHP), which contained both phenolic and non-phenolic lignin substructure units, was also synthesized. They were incubated anaerobically with ruminal microbes with and without bactericidal (penicillin 2000 IU/ml, streptomycin 0.2 mg/ml and chloramphenicol 30 μ g/ml) and fungicidal (cycloheximide 0.5 mg/ml) antibiotics, and their degradations were determined by the fluorescence yield. VAU (12 μ M) were degraded completely within 8 hr by ruminal microbes in the presence of cycloheximide, but no significant degradation occurred in the presence of bactericidal antibiotics. GGU-ET was not degraded significantly even without any antibiotics in 48 hr. F-DHP showed a partial degradation (about 20 %) without any antibiotics. Both the bactericidal and fungicidal treatments showed significant degradation of F-DHP after 48 hr although the incubation with sterilized ruminal fluid by a membrane filter (0.22 μ m pore) showed no degradation. These results indicate that ruminal microbes can cleave non-phenolic benzyl ether linkages in the dimer (VAU) especially by bacteria, but not in the trimeric β -O-4 model (GGU-ET), and they can also degrade the synthetic lignin polymer with both phenolic and non-phenolic benzyl ether bonds (F-DHP).

Key Words: Rumen, Lignin Degradation

1140 Pasturized liquid brewer's yeast and urea on wheat straw utilization by sheep. H. E. Laborde^{*1}, E. Sanz², R. Brevedan¹, and H. Fernandez¹, ¹CERZOS/UNS, 8000 Bahia Blanca, (Argentina), ²ETSEA/UDL, Lleida, Spain.

Ten sheep with rumen fistulas were placed in metabolic cages during three four-week periods with rest periods in a corral between periods. Three diets of treated straw were evaluated: T_{UM} (wheat straw with urea dissolves in water 3% by weight, baled and bagged into hermetic polythene sacks and stored at room temperature for 70 days), T_{LUM} (wheat straw with pasturized liquid brewer's yeast, LCP, 30% on humid base plus 3% urea, stored as T_{UM}), and LT_{UM} (= T_{UM} + LCP sprayed onto the straw at feeding time). The remaining two diets included untreated straw sprayed at feeding time with 3% urea (Trat. S_{UM}) or urea and LCP (Trat. S_{LUM}). All the treatments included 2% of dissolved molasses. All the animals received a daily supplement of 100g of bran plus a mineral-vitamin mixture. The treatment of straw with urea provoked greater (P < 0.05) voluntary intake (VI) than simply supplementing the straw with urea, but only when LCP was added to the straw (T_{LUM}). The digestibility and the VI was better with LCP than the treatment with urea only. This effect was not noticed when LCP was sprayed at feeding time. Urea used as a treatment or a supplement to the straw did not produced marked differences in digestibility or VI. Even though there were differences (P < 0.05) in the organic matter intake provoked by the treatment of straw with urea and supplemented with LCP, these were not sufficient so to be able to observe differences (P > 0.05) in the degradative characteristics of the diets in the rumen, the rate of passage and the microbial protein synthesis.

Key Words: Wheat Straw, Intake, Degradability

1141 Comparison of the nutritive value of perennial cereal rye (*Secale cereale* × *Secale montanum*) silage and barley silage. Z. Mir^{1*}, S. N. Acharya¹, P. S. Mir¹, M. S. Mir¹, and L. A. Goonwardene², ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB ²Alberta Agriculture, Food and Rural Development, Edmonton, AB.

Perennial cereal rye (PCR) is a new 'low-input' cereal crop for production of silage for ruminants, that requires seeding only every four or five years. Silage yields from PCR were similar to barley and averaged 8 to 9 tonnes DM ha⁻¹ yr⁻¹ over four years. A completely randomized design experiment was conducted to compare the composition of silages from PCR and barley and to measure *in vitro* gas production. Whole plant PCR and barley at the soft dough stage were chopped and ensiled in triplicate mini-silos for 94 d. Dry matter of PCR and barley silages was 41.3 and 31.8%, respectively. Crude protein content in PCR silage was lower (P < .05) than in barley silage, and NDF, ADF and lignin contents were higher (P < .05). Total and rate of *in vitro* gas production were similar (P > .05) for the silages, despite the higher fibre content of the PCR. Feeding trials are required to determine voluntary intake and growth performance by ruminants.

Silage	CP ^z	NDF ^z	ADF ^z	Lignin ^z	Ash ^z	Ca ^z	P ^z	(a + b) ^y	c ^y	L ^y
Barley	12.0 ^a	53.8 ^b	30.3 ^b	4.1 ^b	8.9	.53 ^a	.16 ^a	24.2	7.5	.4
PCR	10.0 ^b	59.4 ^a	36.9 ^a	6.0 ^a	8.6	.29 ^b	.13 ^b	22.5	6.6	.5
SEM ^x	.28	.66	.40	.16	.16	.020	.003	.62	.65	.10

^zCompositional data are presented as % (DM basis). ^yGas production kinetics were calculated from $P = a + b(1 - e^{-c(t-Lt)})$ (Dhanao, 1988). (a + b) = potential gas production (mL 100 mg⁻¹ DM); c = rate constant of gas production (% h⁻¹); L = lag time (h). ^xSEM = Standard error of the mean. ^{a,b}: Means within a column bearing different superscripts differ (P < .05).

Key Words: Barley Silage, Perennial Cereal Rye Silage, Silage

1142 Effect of a supplement, mineral salt and ionophore on intake, digestibility and weight gain of growing bullocks (*B. taurus* × *B. indicus*) grazing tropical pastures. G. Olmos-Oropeza, S. S. González*, C. García-Bojalil, R. Bárcena, and J. Ramos, *Colegio de Postgraduados, Montecillo, México.*

Performance of cattle grazing tropical pastures usually is very low. The objective of this study was to evaluate changes on intake, digestibility, weight gain and carcass fat of bullocks grazing tropical pastures and receiving a supplement (dried poultry waste 40%; wheat bran 20%; blood meal 15%; cane molasses 15%; rice bran 7%; tallow 3%), mineral salt and ionophore (Lasalocid). Forty bullocks (*B. taurus* × *B. indicus*); 235 kg initial body weight, BW) grazed two pastures with *Paspalum conjugatum* (89%) and *Cynodon plectostachyus* (11%) 90 days during the rainy season in southeastern México. Treatments (T) were: T1, control (grazing; G); T2, G + supplement (S; 2 kg/d); T3, G + S + mineral salt (MS); T4, G + S + MS with ionophore. Experimental design was completely randomized (10 bullocks/T); means were compared by Tukey test and initial BW was used as a covariable. Addition of S plus MS improved (P < 0.05) ADG (540 g), but total DMI (pasture plus supplement) did not change (P > 0.05). Pasture digestibility was better (P < 0.05) for control animals (56.0%); however, total DM digestibility (pasture plus supplement) was similar (P > 0.05) for all treatments. Carcass fat deposition was increased (P < 0.05) for T3 (50.8 kg) and T4 (39.8 kg). These results suggest that addition of a supplement and mineral salt to bullocks grazing a tropical pasture increase BW gain, intake and carcass fat.

Key Words: Bullocks, Tropical Pastures, Supplement

1143 Roughage level effects in finishing Holstein cattle diets. C. H. Parsons*, T. L. Stanton, D. Davidson, and R. Utmann, *Colorado State University, Fort Collins.*

The objective of this study was to evaluate the performance of finishing Holstein steers fed four different levels (0, 4, 8, and 12% DM) of corn silage in a diet consisting of whole-shelled corn, varying levels of silage, and a pelleted supplement. Sixty-four Holstein steers (mean initial weight of 402 kg) were used in a randomized block design. Steers were allotted to twenty-four small feeding pens, with six pens per treatment. Steers were implanted with Synovex® Plus™ and vaccinated with Bovishield 4® prior to receiving. Treatments were offered ad libitum to steers once daily utilizing a data ranger feeding system at approximately 0800. Steer weights were measured at d 0, 28, 56, and 101. Steer feed intake, average daily gain (ADG), and feed efficiency were calculated from d 0 to d 28, d 29 to d 56, d 57 to d 101, and d 0 to d 101. Dry matter intake (kg/(hd7d) ± SEM) increased linearly ($P < .05$) 8.45, 9.36, 9.94 and $11.29 \pm .57$ respectively as the corn silage level increased. Data indicated no linearity between ADG ($P > .05$) as the corn silage level increased, 1.31, 1.43, 1.20 and $1.30 \pm .14$ (kg/d ± SEM), for the 0, 4, 8 and 12% corn silage treatments, respectively. Feed efficiency (gain (kg)/feed (kg) ± SEM) decreased linearly ($P < .05$) .15, .15, .12 and $.11 \pm .48$ respectively as the roughage level increased. Final off test weights (mean 529 kg) were not different ($P > .05$) between treatment means. Overall, lower level roughage in finishing Holstein steer diets maybe an effective method to decrease cost of production, by decreasing inputs and improving feed efficiency, while not affecting ADG or final selling weight.

Key Words: Roughage level, Finishing performance, Holstein steers

1144 Higher roughage during the first half of finishing and two protein levels for finishing yearling steers. I. G. Rush*, B. A. Weichenthal, and B. G. Van Pelt, *University of Nebraska, Scottsbluff.*

Steer performance and carcass traits may not be affected much when the first half of finishing includes a moderate roughage level. To test this, Angus yearling steers averaging 403 kg initially were randomly assigned to 4 pens of 7 or 8 steers on each of 4 treatments with the following crude protein (CP)% and NEg Mcal/kg DM, respectively, for the first 62 days: 1) 12.0, 1.23; 2) 12.0, 1.34; 3) 13.8, 1.23; and 4) 13.8, 1.32. During the last 64 days, CP levels were 12.3 or 13.8% but treatments 1 and 3 were assigned the same higher NEg levels as in 2 and 4, respectively. Diets consisted of corn, corn silage and pelleted supplement with about 2/3 of the supplemental crude protein coming from urea. Monensin and tylosin were included in all diets which were fed once daily. Steers were implanted initially with Synovex S. Daily gains, calculated by dividing hot carcass weights by a common dressing percentage (62), and gain to feed ratios were not different. The only significant carcass difference was a lower yield grade ($P=.03$) in treatment 3, which was consistent with the slightly lower means for performance, fat thickness and quality grade and likely due to variation in animal performance within replicated pens rather than treatment. Finishing performance and carcass traits in steers fed 12.0% CP and 1.23 Mcal/kg NEg during the first half of finishing were not improved by using higher CP and NEg levels during the first half of finishing or higher CP throughout the entire 126 days.

Treatment	1	2	3	4	P
Daily gain, kg	1.56	1.56	1.42	1.54	.35
Feed DM/day, kg	10.42	10.49	10.52	11.07	.24
Gain/feed ratio	.149	.150	.135	.139	.14
Fat thickness, cm	1.37	1.41	1.20	1.40	.20
Quality grade ^a	19.6	19.7	19.1	20.0	.22
Yield grade	3.4	3.3	2.9	3.4	.03

^aQuality grade scores of 19.0–19.9 = low Choice.

Key Words: Crude Protein, Net Energy, Finishing Steers

1145 Milk production and voluntary intake of crossbred cows grazing elephantgrass (*Pennisetum purpureum*, Schum.) fertilized with two nitrogen levels. J. P. Soares¹, L. J. M. Aroeira^{*2}, C. E. Martins², F. C. F. Lopes², and O. G. Pereira¹, ¹Universidade Federal de Viçosa, Viçosa-MG, ²EMBRAPA Brazilian Dairy Cattle Research Center.

Dry matter availability, milk production, dry matter intake (DMI) and extrusa chemical composition were evaluated in crossbred cows grazing elephantgrass fertilized with two levels of N (300 and 700 kg/ha/year), during two “dry” and two “rainy” seasons in Southeast of Brazil. The pasture was divided in 11 paddocks, grazed (6 cows/ha) during three days, with 30 days of resting periods. During the “rainy” season cows grazed elephantgrass and were supplemented with 2 kg/cow/day of concentrate (18% CP). In the “dry” season cows received the same concentrate and chopped sugarcane plus 1% urea, between the two milkings. Milk production was measured in 12 cows, (6/treatment). DMI was calculated using mordent chromium for fecal production estimation, and digestibility was determined in extrusa collected from two esophageal fistulated cows. Milk production (12 kg /cow/day) was not affected by treatment. Dry matter availability was not influenced by N level, however, higher values ($P < .05$) were found in the “rainy” (2340 kg/ha), than in “dry” season (470 kg/ha). Extrusa chemical composition also varied according to the season of the year. Elephantgrass DMI (10.5 kg or 2.1% of live weight) were similar for both N levels, but they were influenced by season. Elephantgrass contributed with 26% of total DMI during the “dry” season and increased to 84% in the “rainy” season. N fertilization (700 versus 300 kg /ha) was not advantageous to elephantgrass pasture in Minas Gerais State, Southeast of Brazil, not improving DMI or milk production of crossbred cows.

Key Words: Crossbred Lactating Cows, Elephantgrass, Voluntary Intake

1146 Effects of fibrolytic enzyme treatment on forage dry matter and organic matter disappearance. H. H. R. Titi^{*1}, C. R. Richardson¹, and C. W. Cobb², ¹Texas Tech University, Lubbock, and ²Loveland Industries, Inc. Greeley, CO.

An In vitro laboratory experiment using rumen fluid was conducted to determine forage dry matter (DMD) and organic matter disappearance (OMD) when treated with fibrolytic enzymes. Three forages; alfalfa hay, gin trash, and cottonseed hulls were treated with four different fibrolytic enzymes (E1, E2, E3, and E4). Forages were treated with each of the four enzymes at the rate of 0.0, 0.6 .08 and 1.0 oz. per ton. Forages were ground through 1.0-mm screen, sprayed with the enzyme mixture at 10% w/w level and incubated in rumen fluid for 0, 12, 24 and 36h. Enzyme treatment had a higher DMD than the control treatment at all incubation times. After 36 h of incubation, alfalfa treated with E1 was numerically higher than the control treatment (67.88 vs. 66.20%). Other enzyme treatments of alfalfa were higher ($P < .05$) than the control. Gin trash treated samples were higher ($P < .05$) than control at 0, 12 and 24h. At 36h of incubation E1 and E2 were significantly higher than the control but E3 and E4 were significantly lower ($P < .05$). Dry matter disappearance of treated cottonseed hulls was significantly higher than the control for all treatments and at all times. Data for OMD followed the same trend. Treated alfalfa was higher ($P < .05$) than control treatment. Numerically, E1 was higher than the control after 36h of incubation (76.5 vs. 72.71%) and both were lower ($P < 0.5$) than other enzyme treatment. Treated gin trash incubated for 0, 12 and 24h gave OM disappearance higher ($P < .05$) than the control. At 36h, E1 and E2 were ($P < .05$) higher than the control, E3 and E4. No differences ($P > .05$) were observed between E3, E4 and control treatments. For cottonseed hulls, all results showed differences ($P < .05$) of the enzyme treatments compared to the control and at all times. These data suggest that enzyme addition to forages, improves in vitro digestibility and indicates possible application to ruminant feeding.

Key Words: Enzymes, Forages, Digestibility

1147 Metabolizable protein requirement of early lactating beef cows grazing Oklahoma winter tallgrass prairie.

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For lactating beef cows with a peak milk production of 7 kg/d, the metabolizable protein (MP) requirement is predicted at 734 g/d. When feeding an industry standard supplement and using estimated values of forage intake at 2.2% of body weight (BW), forage crude protein (CP) at 4%, forage degradable intake protein (DIP) at 77% of CP, microbial efficiency at 10% of total digestible nutrients (TDN) and TDN at 49%, MP intake was calculated to be deficient by approximately 117 g/d. Undegradable intake protein (UIP) from forage was calculated at 101 g/d and DIP from forage at 338 g/d. Angus x Hereford cows (565.6 kg; 5.5 body condition score (BCS)) were divided into treatments depending on calving date, BCS and age and individually fed one of four protein supplements postpartum until mid April (n=66). Each group received 1.49 kg supplement (soybean meal, soyhulls), 2.61 Mcal NEM and 396 g DIP daily (DIP balance=196g/d) while additional UIP (corn gluten meal, blood meal) was fed in equal ratios and titration fashion to three treatment groups (211, 274, 338 and 401 g UIP/d). Milk production was determined 30 (n=40) and 45 (n=39) days after the average calving date (early March) using the weigh-suckle-weigh technique. Blood samples (n=67) were collected weekly postpartum for plasma progesterone concentration to determine the interval from parturition to the first normal luteal phase. No significant differences were determined between treatments. This could be ascribed to possibly underestimating forage and/or the control supplement UIP and/or forage intake.

	Con	Con+63	Con+126	Con+189
Calculated MP supplied (g/d)	617	674	730	787
MP balance (g/d)	-117	-60	-4	53
BW change (kg)	-66	-69	-68	-61
BCS change	-0.6	-0.6	-0.9	-0.7
Milk production 30 d (kg/d)	8.4	8.3	8.9	8.8
45 d (kg/d)	7.2	7.4	6.8	7.4
Postpartum interval (d)	52	49	46	52

Key Words: Beef Cows, Metabolizable Protein

1148 Evaluation of alfalfa leaf meal in wintering beef cow diets. C. M. Zehnder¹, A. DiCostanzo^{*1}, J. B. Hall², and D. B. Brown³, ¹University of Minnesota, St. Paul, ²Virginia Tech University, Blacksburg, ³North Central Experiment Station, Grand Rapids, MN.

A study was conducted to evaluate effects of substituting alfalfa leaf meal (ALM) for soybean meal (SBM) as the protein source when supplementing low quality hay diets. One hundred pregnant, nonlactating Angus cows (631 kg) and 24 pregnant, nonlactating Angus heifers (470 kg) were assigned by BW, calving date and body condition to one of four dietary treatments for a late gestation wintering period. Dietary treatments consisted of supplementing hay-based diets at 100 or 115% of NRC recommended CP intake using either SBM or ALM as the supplemental protein source. Hay for heifers and cows contained 82.1 and 78.4% DM, 7.4 and 6.1% CP, and 52 and 46% TDN, respectively. Cows were group fed (two replicate pens/treatment) while heifers were individually fed. The study lasted 70 (early calving) or 85 (late calving) d for cows and ended when the first cow in each replicate calved. Heifers were fed dietary treatments until each heifer calved; for an average of 100 d. Heifers fed ALM consumed less ($P < 0.05$) hay (5.7 vs 6.6 kg/hd/d for ALM and SBM treatments, respectively) and corn (1.78 vs 1.90 kg/hd/d for ALM and SBM treatments, respectively) DM. Diet DMI was unaffected ($P > 0.05$) by protein source. Feeding 115% of recommended protein (1.08 vs .94 kg/hd/d) to heifers increased ($P < 0.05$) precalving rate of gain (-.10 vs .11 kg/hd/d for 100 and 115% CP treatments, respectively). Cows fed ALM had greater ($P < 0.05$) rates of gain (.53 vs .34 kg/hd/d for ALM and SBM treatments, respectively) when gain was measured 22 d before calving. Once cows calved, weight change was similar ($P > 0.05$) for each protein source (-.74 kg/hd/d). However, cows fed ALM consumed more ($P = 0.054$) total DM. Calving traits were not affected by protein source or intake. Wintering heifers or cows on ALM-based supplements had no detrimental effect on performance of heifers or cows, or calving traits. Additional protein may be required by heifers to ensure that they continue gaining weight during late gestation.

Key Words: Alfalfa, Cow, Diet

1149 Effect of live yeast culture supplementation on dry matter intake and milk production of transition cows.

N. L. Woodward*, J. A. Shelford, L. J. Fisher, N. E. Dinn, J. Baah, and K. J. Cheng, *University of B.C., Canada.*

A decline of 30–35% in feed intake is common during the transition period in dairy cows. This usually results in the failure of the animals to meet their increased requirements for energy, glucose, amino and fatty acids. The inability of cows to meet their requirements could result in a range of postpartum health problems that could compromise performance. There are indications that the feeding of live yeast cultures of *Saccharomyces cerevisiae* (LYC) to cows in early lactation may increase both DMI and milk production. The objective of this study was to determine if LYC fed to cows both pre- and post-partum could result in increased DMI and milk production. Thirty multiparous cows were paired, based on age, body weight and previous year's 305d milk production, and randomly assigned to one of two dietary treatment groups, A (control) or B (yeast supplemented). Cows were fed a total mixed ration (TMR) twice daily consisting of 85% forage and 15% concentrate on a DM basis. Cows in group B were fed yeast at a level of 0.2% of estimated DMI from one week prior to expected date of calving until 14 days post-partum. The daily allotment of yeast was divided into two equal portions; hand mixed with 1-kg portions of concentrate, and fed twice daily. Cows in group A received 2-kg of unsupplemented concentrate daily. Concentrate levels for both groups were increased by increments of 0.5 kg/cow/day post calving, until completion of the trial. Milk production was recorded daily for all cows until 75 days in milk. Preliminary results indicated differences ($p < 0.05$) between cows in groups A and B in terms of both daily DMI (18.45 vs. 18.8 kg/cow) and milk production (30.90 Vs. 33.48 kg/cow) during the first 14 days of lactation. Daily milk yield from day 15 to 75 also differed ($p < 0.05$) between groups A and B (39.10 Vs 46.1 kg/cow). These results indicate that supplementation with LYC during the transition period improves DMI and milk production.

Key Words: Yeast, Milk, Feed Intake

1150 Effects of pre- and post-partum Alimet[®] supplementation on milk production of dairy cows. L. M. Rode^{*1}, C. D. Knight², K. A. Andrews¹, and K. M. Koenig¹, ¹Agriculture and Agri-Food Canada, Lethbridge, ²Novus International, Inc., St. Louis, MO.

Twenty multiparous and ten primiparous Holstein cows were used to investigate effects of supplementing dairy cow diets with Alimet[®] (DL, 2-hydroxy-4-[methylthio] butanoic acid; HMB; Novus International Inc.) on DMI and milk production. Cows were blocked according to parity, expected calving date, and body condition score (BCS) six weeks prepartum and then randomly assigned to two treatments: control (C) or HMB supplementation (H). Diets were offered as a TMR contained alfalfa hay and haylage, whole cottonseed and barley-based concentrate. Diets were similar for the two treatment groups except that H cows were offered approximately 20 g/d HMB at two weeks precalving and approximately 50 g/d HMB from parturition until 12 weeks postpartum. Diets were balanced using the CNCPS model to provide adequate metabolizable energy and metabolizable protein. Methionine and lysine were provided at 0.89 and 1.09 times requirement in the lactation diet as predicted by the CNCPS model. Dry matter intake was not affected by HMB (H vs C; 17.6 vs 17.5 kg/d) during lactation. However HMB increased DMI (H vs C; 9.9 vs 8.4 kg/d; $P < .05$) and BCS (H vs C; 3.55 vs 3.32; $P < .10$) during the week before parturition. Over the 12 weeks of lactation, supplementation with HMB increased milk production (H vs C; 33.9 vs 31.3 kg/d; $P < .05$), milk fat percentage (H vs C; 4.01 vs 3.71%; $P < .10$) and fat-corrected milk yield (H vs C; 33.4 vs 29.2 kg/d; $P < .01$). Supplementation with HMB did not affect milk protein content but increased milk protein yield (H vs C; 1.61 vs 1.49 kg/d; $P < .10$). During lactation, HMB-supplemented cows lost more body condition (H vs C; 0.33 vs 0.12 BCS units; $P < .10$). Supplementation with HMB in pre-partum diets can alleviate the depression in DMI that occurs just prior to parturition. Supplementation of HMB in lactating diets increases production of milk and fat-corrected milk indicating that HMB can be used as an effective means of meeting methionine requirements of dairy cattle.

Key Words: Methionine, HMB, Lactation

1151 Effects of dietary supplements of rumen-protected methionine and folic acid on lactational performance of dairy cows. C. L. Girard¹*, H. Lapiere¹, J. J. Matte¹, and G. E. Lobley², ¹Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville, Canada and ²Rowett Research Institute, UK.

Fifty-four multiparous cows were assigned to 9 blocks of 6 cows according to their previous milk production in order to determine if the beneficial effects of supplementary folic acid (FA) on milk production and milk protein previously observed, are mediated through the metabolic pathway involving methionine (Met). Treatments were tested according to a 2×3 factorial. During a 305 d lactation, the cows were fed a diet calculated to cover 80% of the Met requirements (M-) or supplemented with rumen-protected Met (Smartamine MTM, 18 g/d; M+). Within each level of Met supplementation, dietary supplements of 0 (F0), 3 (F3) or 6 (F6) mg of FA per kg BW were given daily. Milk production was recorded twice a day and milk composition was determined every 4 wk. None of the treatments changed milk production during the 305 d lactation ($P>0.4$; 10818±175 kg). Supplementary Met increased total solids ($P=0.008$; 12.1±0.6 vs 12.6±0.6%), fat ($P=0.08$; 3.5±0.5 vs 3.7±0.4%), total protein ($P=0.0009$; 3.25±0.25 vs 3.46±0.17%) and casein ($P=0.02$; 2.11±0.05 vs 2.28±0.04%) contents in milk. With M-, F3 increased milk casein content by 7.5% as compared to F0 whereas with M+, FA supplements had no effect (FA×Met, $P<0.1$). With M-, FA did not change whey protein content but M+ F6 was 6% less than M+F0 (FA×Met, $P<0.1$). FA decreased lactose in milk of M- cows (4.83±0.04, 4.66±0.06 and 4.66±0.07% for F0, F3 and F6, respectively) whereas with M+, lactose in F0 (4.68±0.09%) and F3 (4.63±0.1%) was lower than in F6 (4.82±0.07%) (FA×Met, $P=0.05$). Milk contents of NPN and ash were not affected by treatments ($P>0.2$). The present results suggest that lack of provision of methyl groups alone is insufficient to account for the lower lactational performance observed with marginally-Met deficient diets. An optimal level of dietary FA supplementation seems also to be reached in M-F3 cows.

Key Words: Dairy Cow, Methionine, Folic Acid

1152 Interactions of prepartum and postpartum feeding of rumen inert amino acids on lactational performance of Holstein cows. V. M. Carson, N. L. Whitehouse, K. Kolinsky, B. D. Garthwaite, M. S. Piepenbrink, and C. G. Schwab*, *University of New Hampshire, Durham.*

One hundred four multiparous Holstein cows were blocked by expected calving date and assigned to a 2 × 2 factorial arrangement of dietary treatments 21 d before parturition. Prepartum diets were (% of DM): low RUP (4.9 and 13.8 CP), low RUP plus 5.2 g/d Lys and 4.5 g/d Met, high RUP (6.6 and 15.6 CP), and high RUP plus 4.6 g/d Lys and 8.3 g/d Met. Each block contained eight cows and two cows per block received each of the prepartum diets. At calving, one cow from each pair received a basal lactation diet (7.3 RUP and 18.1 CP) and the other cow the basal diet plus 12.9 g/d Lys and 19.5 g/d Met; cows remained on treatments and measurements were made through 70 DIM. Diets were corn-based and all supplemental protein was provided by soybean meal, SoyPassTM (Lignotech) and roasted soybeans; Lys and Met were provided by Smartamine MTM and Smartamine MLTM (Rhône Poulenc). Treatment differences and interactions were considered significant at $P < 0.05$. Postpartum Lys and Met feeding increased DMI when cows had previously consumed the high RUP prepartum diets (24.3 vs. 22.5 kg/d) but had no effect on DMI when cows had consumed the low RUP prepartum diets (23.4 vs. 23.6 kg/d). There were no effects of treatment on milk yield (ave. = 46.1 kg/d), milk urea N (ave. = 15.2 mg/dl), or body condition score change (ave. = -0.64 units). Increases in milk true protein concentrations with postpartum Lys and Met feeding were greater when Lys and Met were not included in the prepartum diet (+0.29 percentage unit) than when they were included in the diet (+0.14 percentage unit). Cows fed the Lys and Met supplemented lactation diet produced more milk true protein than cows fed the unsupplemented diet (1344 vs. 1279 g/d). Feeding Lys and Met during lactation increased concentrations and yields of milk fat when Lys and Met were included in prepartum diets (3.93 vs. 3.63% and 1809 vs. 1669 g/d) but had no effect on fat concentrations (3.85 vs. 3.87%) and tended to decrease fat yields (1739 vs. 1828 g/d) when unsupplemented prepartum diets were fed. Body weight losses of cows fed the Lys and Met supplemented lactation diet were greatest when AA were fed before calving (125 kg) vs. when they were not fed (106 kg), whereas weight losses of cows fed the unsupplemented lactation diet were greatest when no AA were fed before calving (131 kg) vs. when they were fed (100 kg).

Key Words: Lactating Cows, Rumen-Protected Lysine and Methionine

1153 Lipid metabolism and production by Holstein cows fed control or high fat diets at restricted or ad libitum intakes during the dry period. G. N. Douglas*, J. K. Drackley, T. R. Overton, and H. G. Bateman, *University of Illinois, Urbana.*

Previously we found (Grum et al., *J. Dairy Sci.* 79:1850) that cows fed a fat-supplemented diet during the dry period had less hepatic lipid accumulation at calving; however, nutrient intake was depressed by the high fat diet. Sixty multiparous Holstein cows with body condition score (BCS) ≤ 3.5 at dry-off were used to determine the effects of diet and feed restriction during the dry period on hepatic lipid content and subsequent lactation performance. Control (C) or high fat (F) diets were fed from dry-off (60 d before predicted calving date) to calving at either ad libitum or restricted (80% of NEL requirement) intake. Isocaloric diets (1.43 Mcal/kg) consisted of (DM) 50% alfalfa silage, 25% corn silage, and either 25% concentrate (C) or 9% concentrate, 12% oat hulls, and 4% grease (F). A fifth treatment of C plus fat (CF) was supercaloric (1.58 Mcal/kg) and fed for ad libitum intake. All cows were fed a single lactation diet after calving through 105 d postpartum. Liver tissue was obtained by biopsy at -65, -21, 1, 21 and 65 d relative to parturition and concentrations of total lipid and triglyceride were determined. Cows fed either C or F at restricted intake prepartum had greater ($P<0.01$) DMI during the first 21 d postpartum than cows fed ad libitum prepartum. Liver lipid ($P<0.01$) and triglyceride ($P<0.01$) concentrations were lower postpartum for cows fed at restricted intakes than for cows fed ad libitum prepartum. Liver triglyceride at d 1 was 7.8, 3.6, 5.4, 2.9, and 5.2% (wet wt) for C ad libitum, C restricted, F ad libitum, F restricted, and CF, respectively. Prepartum NEFA concentrations were higher ($P<0.001$) for cows fed at restricted intake than for cows fed ad libitum. Postpartum NEFA concentrations were lower ($P<0.05$) for cows fed either C or F than for cows fed CF prepartum. Prepartum BCS was lower ($P<0.05$) for cows fed at restricted intake, but cows fed ad libitum prepartum lost BCS more rapidly after calving (trt × wk, $P<0.001$). Prepartum intake had more pronounced effects on periparturient lipid metabolism and DMI than did diet composition.

Key Words: Dry Cow, Lipid Metabolism, Fatty Liver

1154 Hepatic gluconeogenesis and whole-body protein metabolism of periparturient dairy cows as affected by source of energy and intake of the prepartum diet. T. R. Overton, J. K. Drackley*, G. N. Douglas, L. S. Emmert, and J. H. Clark, *University of Illinois, Urbana.*

Holstein cows ($n = 36$) were fed either high grain (HG) or high fat (HF) diets for ad libitum (A) or restricted (R; 80% of calculated requirements for NE_L) intakes from 60 d prepartum until calving, and then all fed the same lactation diet. Liver was biopsied at -21, +1, +21, and +65 d relative to parturition and slices were utilized to determine in vitro conversion of [1-¹⁴C]propionate (Prop) and [1-¹⁴C]alanine (Ala) to CO₂ and glucose. Conversion of substrates to CO₂ and glucose increased ($P < .001$) at d +1 and +21, and the ratio of glucose to CO₂ increased ($P < .001$) at d +21. Conversion of Prop to CO₂ and glucose was greater ($P < .001$) than that of Ala; however, conversion of Ala to glucose at d +1 and +21 was 198% and 150%, respectively, of that measured at d -21 and conversion of Prop to glucose at d +1 and +21 was 119% and 129%, respectively, of that measured at d -21 (substrate by day; $P = .002$). Feed restriction increased conversion of Prop to CO₂ ($P = .04$) and glucose ($P < .001$) and decreased conversion of Ala to CO₂ and glucose. Metabolism of Prop was modulated by prepartum diet and intake to a greater extent than was Ala. The ratio of 3-methyl histidine to creatinine in urine increased markedly ($P < .001$) shortly postpartum and then declined until d +21, indicating substantial degradation of skeletal muscle protein during the early postpartum period. Potential utilization of AA for gluconeogenesis is greater during the first 21 d of lactation than at other times during the productive cycle. Effects of physiological state on hepatic and whole-body metabolism were much greater than those caused by prepartum diet. Effects of source of energy and moderate restriction of the prepartum diet are more pronounced for hepatic metabolism of propionate than alanine and are minimal by 65 d postpartum.

Key Words: Gluconeogenesis, Dairy Cows, Amino Acids

1155 A mathematical model for describing dry matter intake of transition dairy cows. A. Hayirli^{1*}, R. R. Grummer¹, E. Nordheim¹, P. Crump¹, D. K. Beede², M. J. VandeHaar², and L. H. Kilmer³, ¹University of Wisconsin, Madison ²Michigan State University, East Lansing ³Iowa State University, Ames.

Parity, BW, body condition score (BCS), and DMI data from 299 cows involved in eight experiments at three universities were pooled to obtain equations for predicting DMI of transition cows. An exponential function, $y = a + p \times e^{k \times t}$ best described the feed intake pattern during the final 21 d of gestation. $Y = \text{DMI}$ as a percentage of BW, $a = \text{DMI}$ at -21 d prepartum (intercept), $p =$ the magnitude of intake depression from -21 d prepartum to day of calving, and $e^{k \times t}$ describes the shape of the curve. Cows were categorized as thin (BCS ≤ 3), moderate (BCS >3 and ≤ 4), or obese (>4), and as primi- or multiparous. Values for a , p , and k were generated for each category and differences between values for two categories of cows were determined by z test.

Category of cow	a ¹	p ²	k ³	Rate of change
All cows, n=299	1.91	-0.73	0.24	$-0.18 \times e^{0.24 \times t}$
Primiparous, n=141	1.77	-0.66	0.31	$-0.20 \times e^{0.31 \times t}$
Multiparous, n=158	1.98	-0.79	0.25	$-0.20 \times e^{0.24 \times t}$
Thin, n=44	1.82	-1.02	0.62	$-0.63 \times e^{0.62 \times t}$
Moderate, n=209	1.93	-0.73	0.24	$-0.18 \times e^{0.24 \times t}$
Obese, n=46	1.99	-0.87	0.13	$-0.11 \times e^{0.12 \times t}$

¹Primiparous vs multiparous, $P < .0001$; thin vs moderate, $P < .0001$; thin vs obese, $P < .03$. ²Primiparous vs multiparous, $P < .10$; moderate vs obese, $P < .09$. ³Thin vs moderate, $P < .04$; thin vs obese, $P < .006$; moderate vs obese, $P < .009$.

The DMI (% of BW) of multiparous cows was greater than primiparous cows at 21 d prior to calving; the magnitude of difference was reduced as cows approached calving. Body condition influenced the shape of the curve. As body condition was reduced, DMI depression began later but the rate of depression was greater during the final 3 d prior to calving.

Key Words: Transition Cows, Dry Matter Intake, Mathematical Model

1156 The effects of feeding soy hulls in transition cow diet on lactation and performance of Holstein dairy cows. J. P. Underwood*, J. N. Spain, and M. C. Lucy, University of Missouri, Columbia.

Forty-eight dairy cows were used to determine the effects of partial replacement of long-stemmed forage with soy hulls in the transition diet. The animals were blocked according to parity and calving date, then assigned to one of four treatments: 0%, 15%, 30%, or 45% replacement of grass hay with soy hulls. Cows were fed diets 21 days prepartum to day of parturition, then fed the same total mixed production diet. Individual feed intake was recorded daily. Body condition score and weight were measured bi-weekly. Milk yield was recorded daily. Milk composition and somatic cell count were measured weekly. Cows were synchronized using prostaglandin 50 days postpartum. Cows remained on study until 1 week post-breeding. DMI of the control diet was lower ($P < .07$) one week prepartum compared to 15, 30 and 45% diets (7.03 kg vs. 8.47, 9.38, and 10.50 kg, respectively). There was no difference due to diet in DMI postparturition. Cows fed control diet lost more body condition ($P < .02$) preceding parturition than cows fed 30% diet (-0.28 vs. 0.00 BCS respectively). There were no differences among groups in overall BCS loss. Control cows produced more milk fat ($P < .07$) in the first two weeks of lactation than the 45% cows with no overall effect among groups. There were no differences in milk protein. Cows fed 30% diet peaked earlier and had a higher peak milk yield ($P < .10$) than the control and 45% group (37.69 kg vs. 35.90 and 34.16 kg). Partial replacement of 30% of forage with soy hulls in the prepartum diet improved DMI preceding parturition and reduced body condition loss, which subsequently improved lactation performance.

Key Words: Transition Cow, Soy Hulls, Lactation

1157 Effects of corn processing on performance of prepartum and early postpartum dairy cattle. H. M. Dann*, G. A. Varga, D. E. Putnam, and L. C. Griel Jr., The Pennsylvania State University, University Park.

An experiment was conducted to assess the effects of feeding cracked corn (C) or steam flaked corn (F) on prepartum and postpartum dry matter intake (DMI), body weight (BW), and body condition score (BCS) and postpartum milk yield and composition. Multiparous Holstein cows were assigned to treatments in a 2x2 factorial arrangement. The treatments were cracked corn prepartum and cracked corn postpartum (CC); cracked corn prepartum and steam flaked corn postpartum (CF); steam flaked corn prepartum and cracked corn postpartum (FC); and steam flaked corn prepartum and steam flaked corn postpartum (FF). Treatments started 28 d prior to expected calving date and continued until 42 d postpartum. All cows were fed a TMR ad libitum: prepartum, a TMR with a forage:concentrate of 64:36, 1.6 Mcal/kg NE_L and 13.6% crude protein (CP) was fed; postpartum, a TMR with a forage:concentrate of 50:50, 1.62 Mcal/kg NE_L and 16.5% CP was fed. The prepartum ration contained 21% corn and the postpartum ration contained 24% corn. Using a split-plot analysis, least square means for DMI, BW, milk yield, and milk composition were unaffected ($P > .05$) by treatment. Prepartum corn source did not affect postpartum performance. A trend for higher milk yield ($P < .14$) was observed in cows fed steam flaked corn during early lactation.

Treatment	Prepartum		Postpartum			SEM	
	C	F	CC	CF	FF		
n	33	32	13	14	15	15	
DMI, kg/d	13.6	14.6	18.7	18.1	20.2	18.9	0.82
Body weight, kg	754	759	645	658	674	668	17.0
Body condition score	3.45	3.45	2.87 ^a	3.00 ^{ab}	3.06 ^a	2.81 ^b	0.10
Milk yield, kg/d			40.9	42.7	41.6	44.0	1.45
Milk fat, %			3.69	3.59	3.86	3.52	0.16
Milk fat, kg/d			1.57	1.62	1.67	1.62	0.10
Milk protein, %			2.89	2.94	2.98	2.87	0.06
Milk protein, kg/d			1.24	1.33	1.30	1.33	0.05
Milk lactose, %			4.79	4.77	4.79	4.82	0.07
Milk lactose, kg/d			2.06	2.17	2.10	2.24	0.08

¹Means with different superscripts are significantly different ($P < .05$)

Key Words: Corn Processing, Transition Cow

1158 Effects of dietary lactose compared with ground corn on growth rate of ruminal papillae. J. Xu* and M. S. Allen, Michigan State University, East Lansing.

The objective of this study was to compare the effects of partial substitution of lactose for ground corn on growth rate of ruminal papillae. The goal of lactose addition was to increase production of butyric acid in the rumen for use as an energy source by papillae. Eight ruminally cannulated dry, non-pregnant Holstein cows were used in a crossover design. Treatments were ground corn and a mixture containing food grade lactose, ground corn and soybean meal. This mixture contained equal parts lactose (43%) and corn (43%), and soybean meal was added (14%) to equal the CP content of the corn treatment. Diets were formulated to contain 1.63 Mcal NE_L/kg, 29% NDF, and 16% CP and consisted of 43.5% corn or lactose treatments, 36% mature orchardgrass-timothy hay, 17% soybean meal, and 3.5% minerals and vitamin premix. Diet DM was offered at 1.5% of BW. Each 28 d treatment period was preceded by a 14 d period in which a diet of wheat straw was offered at 1% of BW to shrink the ruminal papillae. Ruminal papillae were biopsied from 3 sites in the rumen on d 0, 14, and 28 of each treatment period. Papillae were scanned and papillae size was determined with image analysis software. Lactose treatment increased surface area, length, and width of ruminal papillae. A significant treatment by week interaction indicated that growth rate of ruminal papillae was greater with lactose treatment compared with ground corn. Rate of growth of ruminal papillae for the lactose treatment was 2.20, 2.24, and 1.83 times that for ground corn treatment for surface area, length, and width, respectively. Inclusion of lactose in dry cow diets might be useful to increase papillae absorptive surface area prior to calving.

Day	Treatment		Lactose/ Corn	P value		
	Corn	Lactose		Treatment	Trt x Day	
Surface area (mm ²)	0	15.9	16.1	1.01	<0.0001	<0.001
	14	19.6	27.4	1.40		
	28	24.5	35.0	1.43		
Growth rate (mm ² /d)		0.0307	0.176	2.20	<0.01	
Length (mm)	0	7.80	7.80	1.02	<0.0001	<0.01
	14	8.60	10.76	1.25		
	28	9.56	11.91	1.25		
Growth rate (mm/d)		0.063	0.141	2.24	<0.02	
Width (mm)	0	2.57	2.51	0.98	<0.01	0.02
	14	2.87	3.22	1.12		
	28	3.22	3.70	1.15		
Growth rate (mm/d)		0.023	0.042	1.83	<0.01	

Key Words: Ruminal Papillae, Growth Rate, Fermentation

1159 Effect of dry matter intake and feeding frequency on ruminal pH in lactating dairy cows. G. R. Oetzel* and K. V. Nordlund, *University of Wisconsin, Madison.*

Acute or subacute ruminal acidosis in lactating dairy cows may be influenced by level of DMI and feeding frequency. We evaluated the effect of two levels of dry matter intake and two feeding frequencies on ruminal pH in 8 multiparous Holstein cows in early lactation. Treatments were high intake - high frequency feeding (HI/HF), high intake - low frequency feeding (HI/LF), low intake - high frequency feeding (LI/HF), and low-intake - low frequency feeding (LI/LF). High intake feeding was ad libitum feeding with a 10% targeted feed refusal. Low intake feeding was 75% of DMI during the adaptation period. High frequency feeding was offering feed six times daily. Low frequency feeding was offering feed twice daily, with removal of the orts (if any) 3 hours after feeding. Treatments were arranged as two replicates of 4 x 4 Latin squares. Treatment periods were 7 days in length. Mean days in milk for the study was 66 days. All cows received the same mixed diet throughout the study. Average composition of the diet was 52.9% forage DM, 7.3% coarse particles, 21.8% crude protein, 28.9% NDF, and 36.9% NFC. Mean milk yield was 38.5 kg/d, and mean milk fat test was 3.17%. Dry matter intake averaged 21.3 kg/d for the high intake treatments and 15.8 kg/d for the low intake treatments. Milk yield was decreased and prevalence of ketonuria was increased by the low intake treatments. Neither milk fat nor milk protein test was affected by treatment ($P < 0.01$). Ruminal pH was measured each minute using an indwelling electrode placed through each cow's ruminal cannula. Mean ruminal pH from days 3 to 7 of each period was 5.90, 6.22, 6.39, and 6.42 for the HI/HF, HI/LF, LF/HI, and LF/LI treatments, respectively. Ruminal pH was lowest ($P < 0.01$) for the HI/HF treatment compared to the other treatments. Area of the ruminal pH curve below 5.8 and 5.5 was also lowest ($P < 0.01$) for the HI/HF diet. The high intake, high frequency feeding treatment was the most likely to contribute to ruminal acidosis.

Key Words: Ruminal pH, Dry Matter Intake, Feeding Frequency

1160 Evaluation of an indwelling ruminal probe to measure diurnal pH variation in dairy cows. J. E. Nocek*¹, G. D. Young¹, and J. G. Allman², ¹ *Spruce Haven Farm and Res Ctr, Union Springs, NY* ² *Chr. Hansen Biosystems, Milwaukee, WI.*

The degree and duration of daily ruminal pH nadir is an important determinant of sub-clinical acidosis. The objective of this study was to evaluate an in-dwelling probe technique for recording diurnal ruminal pH. Three ruminally fistulated cows were fitted with indwelling probes affixed to their canula and connected to a data logger. Readings were recorded hourly. The experiment was a 3 x 3 Latin square design with cows being fed three different diets: 50, 60 and 70 percent grain (DM basis) as a TMR once daily. Feed offerings and refusals were recorded daily. The experimental period was 21 days: six days for adaptation and five 3-day rotations: with probe readings at 4, 6, 8, 12 and 24 hour intervals. At each interval readings were recorded (pre-cleaned), a sample of rumen fluid was taken and pH measured in the lab (LAB). As probes were removed from the rumen, probe ends were cleaned with .1N HCl and reinserted into the rumen and a reading recorded (post-cleaned). No protective pH probe shields were used in this experiment. There were no differences between pre- and post-cleaned pH readings across all diets. Mean time under pH 5, 5.5 and 6 were .2, 2 and 7.2 hours respectively, with dietary differences only existing below pH 6 (5.4 vs. 8.3 and 8.5h for 50, 60, and 70% grain respectively). Diurnal pH profiles were monophasic in nature. The degree of pH decrease after feeding and duration of nadir increased with increasing grain in the diet. Daily DMI increased but was highly variable within the first week after switching to the next higher grain level. These results indicate the use of an in-dwelling ruminal probe without a protective shield, cleaned and calibrated daily can accurately measure diurnal variation in ruminal pH. Transition to higher grain levels increases extent and duration of nadir as well as daily DMI fluctuation.

Key Words: Rumen, pH, Forage:grain

1161 Diurnal ruminal pH profiles of dairy cows during transition and influence of pH on ruminal digestion. J. E. Nocek¹, G. D. Young¹, T. Ueda², I. Shinzato², H. Sato*², T. Fujieda², and H. Suzuki², ¹ *Spruce Haven Farm and Res. Ctr., Union Springs, NY* and ² *Ajinomoto Company, Inc., Japan.*

Critical to the transition process is a smooth adaptation to dietary changes: variation in diurnal rumen pH. Three ruminally cannulated cows calving within ten days of each other were fitted with indwelling ruminal pH probes three weeks prior to expected calving date. They were used to evaluate diurnal variation of ruminal pH in pre- and post-partum and to determine the influence of daily high and low pH levels on ruminal digestion of feedstuffs. Each probe was connected to a data logger and hourly measurements were made through 7 wk post-partum. Cows pre- and post-partum were fed a TMR once daily. In situ digestion of corn silage(CS), haylage(HS) and cornmeal(CM) DM was conducted for 6 h prior to feeding (high pH) and starting 3 and continuing through 9 h after feeding (low pH) 1 wk prior to expected calving date and 1 and 3 wk post-calving. Mean weekly lowest pH was higher for cows during the pre-partum compared to the post-partum period. Area under the curve(AUC) for pH < 6 was greatest for wks 1, 4, 5 and 7 post-partum. This corresponded to a greater number of h/d spent < pH 6 (12.35, 13.5, 10.1 and 15.43 h for wks 1, 4, 5 and 7 post-partum respectively). There was negative ($r^2 = .83$, $P < .003$) relationship between mean weekly lowest pH and time (wk -3 to 7 post-partum). AUC for pH < 6.0 and 5.5 increased from -3 to 7 wks post-partum ($r^2 = .44$ and $.43$, $P < .04$). In situ digestion of CS and HS were not affected by time pre- or post-partum or by pH. CM 6 h digestion was higher wk 1 pre-partum compared to wk 1 and 3 post-partum (54.6 vs 43.3 and 45.5% respectively). CM DM digestion was depressed by lower compared to higher ruminal pH (51.0 vs. 44.5%). This study demonstrates that there is a linear depression in ruminal pH starting 3 wk pre-partum through 7 wk post-partum. Periods of low pH depress DM digestibility of CM.

Key Words: pH, Transition, Digestion

1162 Ruminocentesis to evaluate the relationship between milk fat-protein inversion and subclinical acidosis in commercial dairy cows. J. E. Nocek and G. D. Young*, *Spruce Haven Farm and Res. Ctr., Union Springs, NY.*

Two large (> 1000 cows) herds in Central NY were used to evaluate the relationship between rumen pH and milk fat-protein (MF-P) inversion. Approximately 50 cows were selected from each herd (multiparous, up to 150 DIM) and grouped into three MF-P categories: a) < -.3, b) -.2 to .2 and c) ≥ .3. In both herds, lactating cows were fed a one group TMR once daily and milked twice daily. Both herds had nutritionally similar diets, except herd 1 had free sodium bicarbonate available. Ruminocentesis was performed at approximately 3 to 5 h post-feeding. Cows were restrained in headlocks and a 10cm, 16 gauge needle was inserted blindly into the posterior ventral sac of the rumen. Approximately 5-15 cc of rumen fluid were aspirated. Ruminal pH was measured immediately after collection with a calibrated Twin pH meter. Ruminocentesis was conducted within ten days after milk samples were submitted to NEDHI for composition analysis. A preliminary study comparing ruminocentesis(RC) and indwelling ruminal probe(IDP) measurements showed the following relationship: $RC = .125 + .9703(IDP)$, ($r^2 = .75$, $P < .001$). The profile of rumen pH values in the following categories: ≤5.5, > 5.5 and <5.8, ≥5.8 were: herd 1: 4.0, 16.0 and 80%; herd 2: 21.6, 29.4 and 47%, respectively. At sampling, 17.2 and 18.3% of all cows in herd 1 and 2 respectively demonstrated MF-P inversion. Mean pH values for MF-P inversion categories were: 6.2, 6.13 and 6.17; 5.79, 5.71, and 6.00, respectively. There were no significant linear, quadratic or cubic relationships between rumen pH and MF-P ratio, milk fat percentage or DIM for either herd separately or combined. There was no relationship between the incidence of sole ulcers and rumen pH for either herd. The results of this experiment would indicate that there is no relationship between daily nadir ruminal pH and MF-P inversion. Free choice bicarbonate may aid in elevating daily nadirs in ruminal pH.

Key Words: Fat-protein Inversion, Ruminocentesis

1163 Evaluation of clean bunk management for feedlot cattle. R. J. Cooper*, C. T. Milton, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

A trial was conducted to compare clean bunk management vs conventional ad libitum feeding of feedlot cattle. Ninety six crossbred yearling steers were utilized in a completely randomized design with a 2x2 factorial treatment arrangement. Cattle were placed on feed at two times which was also factored into the analysis. The first treatment factor was previous rate of winter gain, .1 (Slow) vs .7 kg/d (Fast). The second factor was clean bunk management (Clean) vs ad libitum feeding (AL). Ad libitum feeding was conducted so that less than .45 kg/hd remained in the bunk each morning; however, ideally the bunks were never completely empty. Clean bunk management was conducted so that each bunk was completely empty between 2200 and 0700 h. All steers were fed once daily a diet containing 45% wet corn gluten feed, 42.5% dry rolled corn, and 7.5% alfalfa. Cattle were marketed on two dates at approximately equal finish. Days on feed ranged from 102–154, depending on Slow vs Fast and time placed on feed. Winter gain by bunk management interactions for DMI, feed refusal, ADG, and gain efficiency were $P = .14, .08, .03, .02$, respectively. It is unclear why clean bunk management did not affect performance of Fast cattle but reduced performance of Slow cattle. The main advantage of clean bunk management noted in this trial was a decrease in the amount of wasted feed which needed to be removed from the bunk due to weather conditions and spoilage.

	Fast		Slow		(AL vs Clean) P =	
	AL	Clean	AL	Clean	Fast	Slow
DMI, kg/d	11.3	11.4	11.8	11.2	.90	.07
Feed refusal, kg/d	.13	.03	.08	.05	.01	.35
ADG, kg	1.71	1.72	1.77	1.58	.79	.01
ADG/DMI	.151	.152	.151	.141	.71	.01

Key Words: Cattle, Feedlot, Bunk Management

1164 Effects of feeding level and bST on performance of growing Holstein heifers. E. M. Romero-Treviño*¹, E. Gutierrez-Ornelas¹, A. Tapia-Villarreal¹, R. Herrera-Saldaña², and R. Lopez-Franco³, ¹Facultad de Agronomía, UANL, ²Grupo LALA, ³ELANCO (Mexico).

Twenty seven Holstein heifers (215 kg) were randomly assigned to one of three treatments (n = 9, 10, 8) to examine the effects of feeding level and bovine somatotropin (bST). Two groups were fed with two feeding levels (100 and 120% NRC 1989 requirements) and a third group, fed with 120% NRC, was s.c. injected with 250 mg bST every 14 d (120% NRC + bST). The no bST treated groups (100 and 120% NRC) received a saline solution as a placebo. The 100% group were limited-fed (95 g DM/Kg^{.75}) to gain .8 kg/d throughout the experiment and, the other two groups received the same amount but a more concentrated diet to feed them with 20% more of nutrients (120% NRC). Weights were taken every 14 d over the 124-d period. Heifers fed with 120% NRC and 120% NRC + bST tended to have higher ADG ($P = .12$) than the 100% NRC group (.95 and 1.02 vs. .91 kg). No difference was found in DMI, but feed conversion was 12% improved ($P < .01$ in heifers injected with bST (5.8 vs. 6.6). The NRC (1989) may be overestimating nutrient requirements of growing heifers, since the 100% NRC group had higher ADG (19%) than the projected (.95 vs. .8 kg/d). Assuming the same NEm requirements for both groups of animals fed 120% NRC, heifers fed 120% NRC + bST increased ($P < .07$) NEg efficiency (348 vs. 402 g ADG/Mcal NEg) and it was a trend ($P = .16$) to increase protein efficiency (1.04 vs 1.13 g ADG/g CP intake) for those bST treated heifers. Holstein heifers treated with bST improved ADG and growth efficiency.

Key Words: Somatotropin, Heifers, Feeding Level

1165 Effects of restricted intake and implantation on feedlot steer performance and carcass composition. G. N. Hermesmeier*¹, L. L. Berger¹, T. G. Nash¹, and R. T. Brandt, Jr.², ¹University of Illinois, Urbana, ²Hoehst Roussel Vet, Overland Park, KS.

Three hundred and eighty four yearling crossbred steers were used to evaluate the effects of ad libitum and restricted intake (90% ad libitum), implantation of Revalor (REV), Synovex-Plus (SYN), or no implant (CON), and a compositional endpoint of 1.0 or 1.4 cm subcutaneous fat cover at slaughter, on feedlot performance and carcass composition. The GLM procedure of SAS was used to analyze the $2 \times 3 \times 2$ factorial arrangement of treatments. Because restricted steers fed to a backfat endpoint of 1.4 cm had less ($P < .01$) backfat than ad libitum steers, a linear regression for backfat and intake level was used to predict growth performance and carcass composition. Steers fed to a backfat endpoint of either 1.0 or 1.4 cm had similar ($P = .30$) DM intakes. Ad libitum (A) steers gained 15.5% more ($P < .01$) than restricted (R) steers. Steers implanted with REV tended ($P < .07$) to gain more than SYN steers who gained 15.2% more ($P < .01$) than CON steers. Ad libitum steers were 4.8% more ($P < .01$) efficient than restricted. Steers fed to 1.4 cm backfat were 2.9% less ($P < .05$) efficient than those fed to 1.0 cm, and steers implanted with REV and SYN had similar ($P = .47$) gain:feed of .177 and .175, respectively, while CON steers had lower ($P < .01$) gain:feed of .154. Control and SYN steers had similar ($P = .13$) DP; however, REV steers had a 6.1% increase ($P < .01$) in DP when compared to SYN steers. Steers fed to 1.4 cm backfat had higher ($P < .01$) numerical yield grades than steers fed to 1.0 cm, 3.34 vs. 2.71. There was an interaction ($P < .01$) for intake level and implant for marbling score. Marbling scores were lower ($P < .05$) for R*SYN and A*REV compared to other treatments, with R*REV being intermediate to all treatments except A*CON, which was higher ($P < .01$) than R*SYN, A*REV, and R*REV. No interaction for feed intake level and implants was observed for growth performance.

Key Words: Implantation, Restricted Intake, Feedlot

1166 Effect of reconstituting field dried and early harvested grain sorghum on the ensiling characteristics of grain and on the growth performance and carcass merit in feedlot heifers. G. L. Huck*, K. K. Kreikemeier, and K. K. Bolsen, *Kansas State University, Garden City.*

The objective of this study was to determine if reconstituting field-dried and early-harvested grain sorghum affected the fermentation characteristics of the ensiled grain or growth performance and carcass merit in feedlot heifers. In trial 1, grain sorghum was harvested at 14% moisture, rolled, and reconstituted to 25, 30 or 35% moisture (75, 70, and 65% DM), then ensiled in laboratory-scale silos. Lactic acid concentration increased more rapidly (d 5 to 90) and pH declined more rapidly (d 3 to 90) as moisture level increased ($P < .05$). In trial 2, 288 heifers (BW = 286 ± 83 kg) were used to compare the effect of feeding rolled, ensiled grain sorghum harvested at 25% moisture (75% DM) to the same grain reconstituted to 30 or 35% moisture (75 and 65% DM, respectively) on growth performance and carcass merit. A steam flaked corn (SFC) diet served as the control. Final live weight; ADG; hot carcass weight; backfat depth; marbling score; kidney, pelvic, and heart fat; and liver abscess score were not affected by grain treatment ($P > .10$). Dry matter intake was highest ($P < .10$) for heifers fed the 25 or 30% moisture grain sorghum diets and lowest for those fed the SFC diet, with DMI for heifers fed the 35% moisture grain sorghum diet being intermediate. Feeding 35% moisture grain sorghum improved gain efficiency ($P < .10$) compared with feeding 25 or 30% moisture grain sorghum by 9.0 and 5.7% respectively. We conclude that reconstituting grain sorghum beyond the typical moisture levels of 25 to 30% would enhance the fermentation characteristics of the ensiled grain and improve gain efficiency in feedlot heifers.

Key Words: Grain Sorghum, High-moisture, Feedlot Performance

1167 Impact of Withholding Feed on Weight and Composition of Ruminal Contents of Feedlot Cattle. S. Janloo*, H. G. Dolezal, F. N. Owens, and A. La Manna, *Oklahoma State University, Stillwater.*

Prior to marketing finished cattle, some feedlots withhold feed to reduce cost. To determine how weight and composition of ruminal contents change during fasting, ruminally cannulated heifers (410 kg) were used in three experiments. In trial 1, an 84% concentrate diet based on rolled corn was fed to 10 heifers. Ruminal contents were fully evacuated at 0, 12, 24, and 36 h after the last meal; heifers were rotated among withdrawal times during the 4-one week periods. Screened solids and filtered liquid were analyzed. Mass of ruminal contents decreased steadily for 24 h but less rapidly thereafter. At 24 h, weight of ruminal contents had decreased ($P < .01$) by 20.5% while weight of organic matter and chemical oxygen demand (COD, kg) had decreased ($P < .01$) more drastically (42.9 and 40.6%, respectively). In trial 2, six heifers were fed the diet above either without or with monensin at 33 ppm. Again, weight of ruminal contents at 24 h had decreased by 18.7% while ruminal organic matter had decreased by 58.7%. For trial 3, six heifers were transported to Goodwell, OK and fed 92% concentrate feedlot diets based on either high moisture or steam flaked corn. Weight of wet ruminal contents, being much lower with processed than with rolled corn diets, had decreased by only 6.3% at 24 h although organic matter and COD again had decreased by 48.1 and 45.9%. Live weight losses at 24 h averaged 2.3, 0.4 and 0.7% for the three trials. Ruminal loss by 24 h was less for ADF than for DM or organic matter. At 24 h of feed withdrawal, ruminal pH had increased to values above 6.5; reduced acidity should permit fiber digestion rate to resume. Despite little reduction in wet volume, the decrease in COD from withholding feed for 24 h prior to harvest indicates that the pollution potential of ruminal contents for packing plants could be reduced by about 40%, a substantial reduction considering that live weights were not markedly reduced. Adverse effects of fasting on carcass weight and quality need further study.

Key Words: Rumens Contents, COD, Fasting

1168 Follicle activity and fiber growth patterns of Angora goats in natural photoperiod. A. J. Litherland, C. Toerien*, T. Sahlu, and J. Luo, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

The objective of this experiment was to describe the seasonal fleece growth cycle in U.S. goats with ambient climatic conditions, and to determine effects of level of feed intake on the cycle. From September 13, 1995 to October 9, 1996, 20 mature, nonpregnant Angora does ($30.2 \pm .9$ kg BW; $2.45 \pm .09$ kg 6-mo fleece weight) were maintained in .4-ha paddocks (previously heavily stocked for low available forage mass; five does per paddock). In addition, a diet (2.46 Mcal ME/kg and 13.6% CP; DM basis) was offered at an average of .53 (L) or .68 kg DM/d (H) in order to maintain or slowly increase BW, respectively. Skin sections, for the determination of follicle activity (FA), and patch fleece regrowth samples were collected monthly. Minimum FA occurred 1 mo after the winter solstice and averaged 8 ± 3 and $78 \pm 4\%$ in primary and secondary follicles, respectively. Fleece growth rate, fiber diameter, and fleece medullation were 40, 15, and 120% lower ($P < .05$), respectively, in the winter than summer. Fleece growth rate and fiber diameter were maximal 1 mo before the autumn equinox. The H goats had a 20% greater shorn fleece weight than did L goats ($P < .05$). Overall, H and L goats had similar ($P > .10$) clean fiber regrowth rates (1.10 vs 1.02 mg/(cm² · d)⁻¹), yield (67.5%), and diameter (35.3 vs 33.6 μm). Spring primary FA was lower for L compared with H goats ($P < .05$), but secondary FA, follicle medullation, and fleece kemp level were unaffected by level of feed intake ($P > .10$). In conclusion, U.S. Angora goats, with constant levels of feed intake, exhibit seasonal follicle and fiber growth cycles, which may impact efficiency of feed use for mohair growth throughout the year. Level of feed intake can affect fleece weight and seasonal changes in primary FA.

Key Words: Angora Goat, Season, Fleece Growth

1169 The impact of a mid-gestation trenbolone acetate implant on beef cow dietary energy use. J. J. Michal*, K. A. Johnson, S. P. Maki, W. H. Wilson, and J. J. Reeves, *Washington State University, Pullman.*

Sixteen beef cows were used to investigate the impact of a mid-gestation implant of trenbolone acetate (TBA) on dietary energy use. Eight cows served as non-implanted controls (C) and 8 were implanted with one 200 mg dose of TBA on approximately day 115 of gestation (range 98 to 132 days). Cows were penned individually and fed for weight maintenance. The diet consisted of (DM basis): 17% alfalfa haylage, 33% alfalfa hay, and 50% grass hay. The calculated metabolizable energy (ME) content of the diet was 1.66 Mcal/kg. Cows had ad libitum access to trace mineralized salt and water. Cow feed intake was measured daily and body weight (BW) and body condition scores (BCS) were recorded monthly. Calving records, gestation length, calf birth weight, and calving difficulty scores were also recorded. Heat production at estimated weight maintenance (MHP) and after a 48 hr fast (FHP) was measured using six cows per treatment. Actual maintenance requirements (ME_m) were calculated using linear regression of ME intake (kcal/MBS) on retained energy (RE; kcal/MBS). There was no effect of TBA implant on cow feed consumption (C: 12.1 kg/d; TBA 11.4 kg/d ± .56; $P = .15$). All cows gained BW over time but this gain was not affected by treatment (C, 14.5 kg; TBA, 37.7 kg; $P = .17$). Body condition score was also unaffected by treatment. Implants did not impact gestation length or calving difficulty score but resulted in heavier calf birth weights (C 37.3 kg vs TBA 42.1 ± 2.8 kg; $P = .03$). There were no differences in FHP (C, 121.3; TBA, 116.1 ± 8.1 kcal/MBS), RE or calculated ME_m (C, 158.7; TBA 150.3 ± 11.2 kcal/MBS) and there was a tendency for MHP to be reduced in TBA treated cows (C, 152.4; TBA, 143.4 ± 6.3 kcal/MBS; $P = .10$). Mid-gestation implants of 200 mg of TBA did not alter energy balance in beef cows.

Key Words: Beef Cows, Trenbolone Acetate, Energy

1170 Effects of restriction strategy and protein source on digestibility, feedlot and carcass performance of growing heifers. A. E. Wertz*, L. L. Berger, and T. G. Nash, *University of Illinois, Urbana.*

Heifers (n=140) were randomly allotted to two 42d replicated periods of ad libitum hay (ALH), ad libitum concentrate (ALC), constant concentrate fed to achieve 1.1 kg/d ADG (CCG), or concentrate at 80% of ALC intake for 21d and then ALC for 21d. Half the restricted-refed heifers were supplemented undegraded intake protein (UIP) (RRUP), the remaining half received degraded intake protein (DIP) (RRDP). The ALC and ALH heifers were slaughtered at a compositional fat endpoint (1.3 cm), while RRUP, RRDP and CCG heifers were slaughtered with the ALC heifers regardless of external fat cover. The ALH heifers, required more days to finish, gained slower and were less efficient ($P < .05$) than other treatment heifers. Restriction strategy did not affect ADG or feed efficiency (G:F). Initial 42d G:F was improved ($P < .05$) with the addition of UIP. Restricted intake of RRUP and CCG diets improved DM and CP digestibility ($P < .05$). The addition of UIP tended ($P \leq .10$) to improve DM, OM, and GE digestibility. The ALC heifers had thicker ($P < .05$) external fat cover than the restricted intake heifers. However, quality grades were similar among ad libitum and restricted intake heifers. Restricted intake of concentrate diets improved heifer ADG relative to ALH, and maintained G:F similar to ALC. Restricted intake of concentrate diets reduced external fat without compromising carcass quality. The inclusion of UIP in restricted intake diets improved G:F and digestibility.

Item	ALH	ALC	RRUP	CCG	RRDP	SE
Period I (0-42d)						
ADG, kg/d	.96 ^c	1.68 ^a	1.38 ^b	1.41 ^{bd}	1.19 ^{bce}	.08
G:F, kg/kg	.148 ^c	.242 ^a	.240 ^a	.247 ^a	.202 ^b	.01
Period II (42-86d)						
ADG, kg/d	1.04 ^b	1.54 ^a	1.42 ^a	1.42 ^a	1.43 ^a	.07
G:F, kg/kg	.130 ^c	.182 ^b	.201 ^{ab}	.208 ^a	.204 ^{ab}	.008
Cumulative Performance						
Days	178 ^a	148 ^b	149 ^b	145 ^b	145 ^b	1.57
ADG, kg/d	1.21 ^c	1.46 ^a	1.32 ^b	1.32 ^b	1.28 ^{bc}	.04
G:F, kg/kg	.141 ^b	.175 ^{ad}	.169 ^a	.173 ^a	.164 ^{ae}	.004

^{abc} Means within a row differ as a result of treatment ($P < .05$).

^{de} Means within a row differ as a result of treatment ($P < .10$).

Key Words: Restricted-intake, Heifers, Undegraded Intake Protein

1171 The effect of including a β -glucanase preparation in the finishing diet on feed efficiency and carcass characteristics of yearling feedlot bulls intended for slaughter. D. R. ZoBell^{*1}, T. A. McAllister², A. N. Hristov², J. D. Popp³, T. Entz², and R. B. Cook², ^{1,3}Alberta Agriculture, Food and Rural Development, ¹Lethbridge and ³Medicine Hat, AB; ²Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB.

An exogenous polysaccharide-degrading enzyme preparation described as a β -glucanase (GNC Bioferm Inc., Saskatoon, SK) was included at 0, .5, 1.0 and 2.0% (DM basis) in a barley-based finishing diet fed to 124 yearling bulls in 12 pens for 56 d prior to slaughter ($n = 3$). The diet contained (DM basis) 75.6% steam-rolled barley, 12.5% barley silage and 12.0% supplement containing vitamins and minerals to meet NRC requirements. When included, enzyme preparation replaced rolled barley in the diet. The bulls (initial weight 495 ± 8.2 kg) were ranked by weight and assigned randomly to diet group. Control diet was provided to all bulls for one week prior to commencement of the treatment period (d 0). Feed was provided on an *ad libitum* basis, and intake and animal weights were determined on d 0, 14, 35 and 56. Data were analyzed by regression analysis using orthogonal polynomials to determine linear, quadratic and cubic effects of enzyme supplementation on rate of gain, feed conversion efficiency and carcass characteristics. Overall rates of gain with 0, .5, 1.0 and 2.0% enzyme in the diet were 1.75, 1.66, 1.55 and 1.63 kg d⁻¹, respectively, and overall feed efficiencies (feed gain⁻¹) were 5.13, 5.71, 5.93 and 5.52. Enzyme did not affect ($P > .05$) rate of gain, feed efficiency, or carcass characteristics (warm weight, grade fat, ribeye area, marbling score and percent carcass lean). Adding an exogenous β -glucanase preparation to the finishing ration did not improve growth performance or carcass characteristics of short-keep feedlot bulls.

Key Words: β -Glucanase, Feedlot Bulls, Exogenous Enzyme

1172 Effect of dietary sunflower oil and pasture forage maturity on conjugated linoleic acid (CLA) content in milk fat from lactating dairy cows. J. M. Griinari^{1*}, K. Nurmela¹, A. Sairanen², J. I. Nousiainen², and H. Khalili², ¹Valio Ltd., Helsinki ²Agricultural Research Centre (MTT), Jokioinen, Finland.

Pasture feeding is reported to increase conjugated linoleic acid (CLA) content in milk fat. In a preliminary study, CLA content in milk fat increased only marginally (+10%) when cows were grazed on mixed grass pasture (*Phleum pratense*, *Festuca pratensis*) compared to cows fed grass silage based diets. However, CLA content in milk tended to increase towards the end of the season suggesting that change in the pasture forage quality may have an effect. Also, average total lipid content of the pasture forage was relatively low (2.4% ether extract in DM) suggesting that supply of precursors might have been limiting the formation of CLA. Therefore, our objective for this follow up study was to determine the effect of forage maturity of mixed grass pasture and dietary lipid addition on milk fat CLA content. Sixteen late lactation cows were assigned to two groups of pasture forage maturity. The difference in forage maturity was achieved by delaying grazing for the late group by approximately one week. Furthermore, cows were assigned within each group, to a three period (21 d each) cross over sequence of oil/no oil additions. Sunflower oil (0.3 kg/d) was fed in a mixture of fibrous byproduct feed (1.2 kg/d). Milk samples were collected during the last two days of each period. CLA content (% of total fatty acids) was not affected by the forage maturity but there was an increase due to the addition of oil (0.9 vs 1.2; $P < .001$). CLA content was lower during the first of the three pasture periods (0.7 vs 1.3 vs 1.4; $P < .001$). This period effect could not be explained and it warrants further study.

Key Words: Conjugated Linoleic Acid, Forage Maturity, Dietary Oil

1173 Calcium soaps of palm oil and olive oil fatty acids fed to Holstein cows. M. Antongiovanni^{1*}, F. Costantini², S. De Vincenzi², and M. Pauselli², ¹Dipartimento di Scienze Zootecniche, Firenze, ²Istituto di Zootecnica Generale, Perugia (Italy).

A high mono- and polyunsaturated to saturated fatty acids ratio in milk fat is claimed to be beneficial to human health. About half of the fatty acids of milk fat arise directly from dietary long chain fatty acids and, therefore, there is a good potential to alter the fatty acids composition of milk fat by dietary means. Feeding Ca salts of olive oil fatty acids instead of palm oil soaps to lactating cows may increase the unsaturated to saturated fatty acids ratio, so improving the milk fat quality. Nine primiparous lactating Holstein cows (535 ± 35 kg of BW) were used in a Latin square design during three 2-wk trials. All diets consisted of 18% corn silage, 31% alfalfa hay, 7% beet pulps and 44% concentrates (DM basis). Diets M400 and M320 supplied 400 and 320 g/d/head of Ca soaps of palm oil; diet L320 supplied 320 g/d/head of Ca soaps of olive oil fatty acids (Liposol). The objective of this study was to compare two levels of palm oil soaps and two different types of soaps at the lower level. Dry matter and net energy intakes of cows fed diet L320 were significantly higher ($p < 0.001$) than both those of diets M320 and M400. Milk yield was also higher, even if not significantly. The higher the milk yield, the lower the fat content, again not significantly. It seems likely that a reduced amount (80%) of Ca soaps of olive oil fatty acids may replace 100% of palm oil soaps without depressing the milk yield, but even slightly increasing it. It is possible that the unsaturated fatty acids composition of milk fat be improved. Further analyses are being carried out.

Diets	M400	M320	L320
Dry matter intake (kg/d)	18.24 ^A	18.30 ^A	18.77 ^B
Net energy intake (Net, kcal/d)	31,110 ^A	30,957 ^A	31,654 ^B
Milk yield (kg/d)	28.10	27.87	28.32
Milk fat (%)	3.54	3.50	3.39

Key Words: Calcium Soaps, Olive Oil, Milk Fat

1174 Alterations in source of inoculum and fat level in the substrate influence the kinetics of lipolysis and biohydrogenation. T. M. Beam^{*} and T. C. Jenkins, Clemson University, SC.

The objective of this study was to determine how diet of the cow, inoculum collection time, and level of soybean oil in the substrate affected the kinetics of lipolysis and biohydrogenation (BH). In vitro incubations for all experiments consisted of 2 g of bermuda grass hay substrate, 40 ml of ruminal inoculum from a fistulated cow, and 160 ml of buffered medium. All incubations (conducted in triplicate) were run anaerobically at 40 C in a water bath. Samples were freeze-dried and analyzed for total fatty acid content by gas chromatography. A separate sample was extracted and analyzed for neutral lipids isolated by solid phase extraction on aminopropyl columns. Rates of BH were expressed as the disappearance rate of cis18:1 or 18:2 for each treatment calculated from the slope of the linear regression relating the natural logarithm of fatty acid concentration (% of the total fatty acids) versus incubation time (0 to 24 or 48 h). Extents were calculated as percent disappearance of cis18:1 and 18:2 for BH and disappearance of neutral lipid for lipolysis. Rates of BH declined from 7.11 to 4.85%/h for 18:1 and 11.86 to 7.36%/h for 18:2 as soybean oil increased in the substrates from 2 to 10%. When in vitros were run twice a day for three days, using inoculum from a single cow fed a consistent diet, rates of BH varied from 3.4 to 6.8%/h for 18:1 and 7.9 to 8.6%/h for 18:2, extent of BH varied from 50 to 75% for 18:1 and 78 to 90% for 18:2 and lipolysis varied from 87 to 95% ($P < .05$). When four diets (combination of high and low levels of hay and fat) were fed to four fistulated Holstein cows in a 4x4 Latin square, rates of 18:1 and 18:2 BH and extent of 18:1 BH were not affected by diets ($P < .05$). Extent of 18:2 BH was higher for high hay diets ($P < .05$). Results indicated that with increasing concentrations of soybean oil rates of 18:1 and 18:2 BH and extents of 18:2 BH were decreased. Level of hay and fat had no effect on rates of BH. Extent of 18:2 BH was higher when more hay was fed.

Key Words: Lipolysis, Biohydrogenation, In Vitro

1175 Lactation performance of Jersey cows fed various combinations of canola oil and canolamide. D. D. DeLuca*, T. C. Jenkins, E. J. Thies, and J. H. Hampton, *Clemson University, Clemson, SC.*

Six lactating Jersey cows were used in a 6 x 6 Latin square experiment to determine how lactation performance is affected by a dietary fat supplement containing different ratios of canola oil and canolamide. The control diet contained no added fat. All other diets contained 3% added fat consisting of 0, 25, 50, 75, and 100% canolamide and the remainder canola oil. Each period lasted 14 days and data was collected during the final 4 days of each period. Dry matter intake was reduced ($P < 0.05$) by the addition of fat to the diet, but not by the level of canolamide. Dry matter intake was 15.7, 13.8, 13.9, 13.9, 13.3, 13.4 kg/d for the control, 0, 25, 50, 75, and 100 diets. Milk yields were 21.0, 21.6, 22.2, 21.5, 21.4, and 20.7 for the control, 0, 25, 50, 75, and 100 diets. Fat corrected milk declined ($P < 0.05$) linearly as amide increased in the fat supplement (23.8, 24.3, 23.9, 23.1, and 21.9 kg/d for the 0, 25, 50, 75, and 100 diets). Efficiency of milk production (kg milk/kg dry matter intake) increased ($P < 0.05$) by the addition of fat to the diet, but was not affected by amide content of the fat supplement. Milk fat and protein percentages were reduced ($P < 0.05$) by adding fat to the diet. Canolamide reduced ($P < 0.10$) milk fat percentage in a linear fashion (4.15, 4.13, 4.24, 4.03, and 3.84 % for the 0, 25, 50, 75, 100 diets), but the amide had no effect on milk protein percentage. Milk protein yield was not affected by diet. Canola oil and canolamide in this study had similar effects on dry matter intake and milk production, but the amide reduced milk fat percentage and fat corrected milk compared to canola oil.

Key Words: Amide, Canola Oil, Lactation

1176 Effects of continuous infusions of canola oil into either the rumen or the abomasum of lactating dairy cows on milk composition and nutrient digestion. S. E. Echelmeier*, E. J. DePeters, H. Perez-Monti, and S. J. Taylor, *University of California, Davis.*

Five multiparous Holstein cows (134 DIM) fitted with ruminal and duodenal cannulas were used to determine the effects of continuously infusing increasing amounts of canola oil (CO) into either the rumen (R) or the abomasum (A) of lactating cows on (1) the fatty acid composition of milk fat, (2) the fat and nitrogen composition of milk, (3) nutrient digestion in the rumen, and (4) production performance. A basal diet containing 2% fat (grease) was fed to all cows. Treatments included (1) no oil infused (C), (2) 200 g/d of CO infused into the R (R200), (3) 400 g/d of CO infused into the R (R400), (4) 200 g/d of CO infused into the A (A200), (5) 400 g/d of CO infused into the A (A400). Milk yield was not increased by CO treatments above C. Milk yield was higher ($P < 0.09$) for R infusion compared to A infusion of oil. All oil infusion treatments increased ($P < 0.02$) the yield of 4% FCM compared to the C. Yield of FCM averaged 33.6, 35.2, 36.4, 34.4, and 35.3 kg/d for C, R200, R400, A200, and A400. Milk fat content averaged 3.37, 3.55, 3.59, 3.39, and 3.73% for C, R200, R400, A200, and A400. Increasing the amount of CO infused into the A increased ($P < 0.01$) fat percent. Milk composition of protein, lactose, and SNF was not affected by treatments. All CO treatments decreased the proportions of short and medium chain fatty acids and increased the proportions of long chain fatty acids compared to the C. Abomasal infusion of CO resulted in lower C16:0, C18:0, and C18:1 n11 trans and higher in C18:1-cis, C18:2, and C18:3 compared to R. Acetate : propionate ratios were higher ($P < 0.02$) for R200 and R400 compared to A200 and A400. Intake of NDF was greater ($P < 0.01$) for R compared to A by approximately 0.4 kg NDF/d. Ruminal and total tract digestibilities of NDF were not different for R and A.

Key Words: Canola, Oil, Infusion

1177 Effect of high-oil corn on content of conjugated linoleic acid (CLA) in beef. M. A. McGuire*, S. K. Duckett, J. G. Andrae, J. G. Giesy, and C. W. Hunt, *University of Idaho, Moscow.*

Conjugated linoleic acids (CLA) are a mixture of octadecadienoic acids shown unequivocally to possess anticarcinogenic properties. Bacteria present in the rumen isomerize linoleic acid to form CLA. Thus, meat and milk products from ruminant animals are the foods richest in CLA. Increasing the availability of linoleic acid to rumen bacteria should increase the content of CLA in muscle of beef. Thus, the hypothesis of this study was that altering rumen conditions and level of substrate would increase the concentration of CLA in muscle of beef. Thirty finishing beef steers were randomly assigned to one of three dietary treatments: 1) normal corn (4.86% oil) formulated at 82% of diet dry matter with 12% silage; 2) high oil corn (7.04% oil) formulated at 82% of diet dry matter with 12% silage; and, 3) an isocaloric diet to treatment 1 with high oil corn (74% high oil corn, 20% silage). All diets were isonitrogenous. Animals were fed these diets for 84 d and then slaughtered. Samples of longissimus dorsi were collected for determination of CLA content. Lipid was extracted using chloroform and methanol, and fatty acids were esterified using sodium methoxide. Concentrations of CLA were determined by gas chromatography using a 100 m CP-Sil 88 column with temperature gradient programming. Identification of fatty acids was by retention time comparison with known standards. The CLA reported is the cis-9, trans-11 isomer. Other isomers of CLA were present in beef but require other procedures for adequate identification and quantification. Concentrations of cis-9, trans-11 CLA tended ($P < 0.06$, SEM = 0.33) to differ (3.92, 3.81, and 4.87 mg/g lipid) for the normal corn, high oil corn and isocaloric diets, respectively. The concentration of cis-9, trans-11 CLA was greatest ($P < 0.02$) in the isocaloric diet as contrasted to the other two diets. A substantial increase in the substrate supply (linoleic acid) failed to increase CLA content in beef unless more forage was available. This supports the concept that cellulytic bacteria promote the production of CLA in the rumen.

1178 Digestibility of tallow fatty acids by wethers fed a barley diet. M. L. Nelson*, T. Schwegel, and R. J. Criswell, *Washington State University, Pullman.*

A balance trial was conducted to titrate effects of tallow on energy metabolism of wethers. Six levels of tallow (0, 2, 4, 6, 8, or 10%) in a barley finishing diet were fed to six crossbred wethers (40 kg) in a randomized complete block design. Diets were 73% barley, 10% tallow and/or bentonite, 10% alfalfa and 7% supplement. We previously reported large decreases in methane emission with added tallow and that the energy value of tallow (calculated by difference) was low. Total tract fatty acid digestibility of tallow was calculated by linear regression, without intercept, after accounting for the fatty acids digested from the base diet (0% tallow fed wether in a period). Fatty acids of the same carbon length were pooled for the regression analysis. All linear regressions were significant ($P < .10$) indicating no effect of level of tallow on fatty acid digestibility. Lauric acid had low digestibility. The high digestibility of all C16 and C18 fatty acids suggest an effect of tallow on endogenous and microbial fatty acid excretion. Fatty acid digestibility was probably a minor contributor to low energy content of tallow, calculated by difference, in these diets.

Fatty acid	C12	C14	C15	C16	C17	C18	C20	SE
Digestibility, %	38.2 ^a	86.5 ^c	72.2 ^b	89.0 ^c	81.8 ^{b,c}	103.6 ^d	88.9 ^c	4.18

^{a,b,c,d}Means with different superscripts differ ($P < .10$).

Key Words: Wethers, Barley, Tallow

1179 Effects of feeding whole oilseeds to partially replace calcium soaps of fatty acids on dairy ewes' intake and milk production and composition. D. R. Osuna, R. Casals*, G. Caja, and S. Peris, *Universitat Autònoma de Barcelona. 08193 Bellaterra, Spain.*

Eight Manchega (MN) and 8 Lacaune (LC) dairy ewes (57 DIM) were used in a replicated 4x4 latin square (3 wk periods) to determine the lactational effects of supplementing diets with fat coming from calcium soaps of fatty acids (CaS) or from a mixture of CaS and whole cottonseed (WCS) or sunflower seeds (SFS). Diets were offered as a TMR and contained (DM basis) 40% dehydrated whole-plant corn, 20% alfalfa hay, 11% orange pulp and 29% concentrate, where fat supplements were included. Treatments were: 1) Control; 2) 5.5% CaS; 3) 2.5% CaS+11% WCS; and 4) 2.5% CaS+4% SFS. Diets were isonitrogenous (16% CP) and their ether extract increased from 2.5% (control) to 7% (fat supplemented). Due to the dietary fat, DMI tended to decrease, milk fat percentage and yield were increased, and casein content was reduced. Milk yield was not affected by treatments and no interactions were found between breed and fat supplementation, in spite of the respective differences ($P < .01$) between MN and LC ewes in milk yield (.9 and 1.6 kg/d), and fat (8.8 and 7.2%) and protein (6.2 and 5.6%) percentages. Blood serum concentrations of NEFA, triglycerides and BHBA were increased by dietary fat. In contrast, glucose and urea were not modified. Main results were:

	Control	CaS	CaS+WCS	CaS+SFS	SEM	P<
DMI, kg/d	2.32	2.20	2.26	2.05	.114	.16
Milk, kg/d	1.25	1.24	1.23	1.24	.018	.98
Fat, %	6.76 ^b	8.60 ^a	8.84 ^a	8.00 ^a	.009	.0001
Fat, g/d	80 ^b	103 ^{ba}	107 ^a	95 ^{ba}	12.3	.035
Protein, %	5.92	5.73	6.12	5.85	.002	.23
Protein g/d	71	70	73	70	1.2	.96
Casein, %CP	88.4 ^a	86.9 ^b	87.7 ^{ba}	87.6 ^b	.01	.0001

Key Words: Dairy Ewes, Calcium Soaps, Whole Oilseeds

1180 Milk yield and reproduction of dairy cows fed saturated or unsaturated fat. H. V. Petit^{1*}, R. J. Dewhurst², J. G. Proulx¹, M. Khalid³, and W. Haresign³, ¹*Dairy and Swine Research and Development Centre, Agriculture and Agri-Food Canada, Lennoxville, QC, Canada*, ²*Department of Animal Science and Microbiology, IGER, Aberystwyth, Wales*, and ³*Welsh Institute of Rural Studies, The University of Wales, Aberystwyth, UK.*

The effects of feeding fatty acids with different metabolic pathways on milk composition and reproduction were studied using 35 Holstein cows assigned to five groups of cows blocked for similar calving dates. At 9 wk postpartum, cows within block were allotted to one of two fat treatments: Megalac (MEG) or whole formaldehyde treated linseed (LIN). Cows were fed ad libitum and milked twice daily until wk 19 of lactation. Milk production was recorded daily, and milk composition, BCS and BW were determined weekly. Timing of ovulations and corpora lutea formation were estimated from sustained elevations in milk progesterone concentration. Ovaries of cows on the last 3 groups were examined by ultrasonography every 2 d from wk 4 to 6 of the experiment. Changes in BW and BCS were not affected ($P > 0.05$) by treatment. Milk yield was higher for cows fed MEG than for those fed LIN (19.8 vs. 18.6 kg/d). Percentage of protein was higher ($P < 0.05$) for cows fed LIN compared to those fed MEG (3.09 vs. 2.95%). Protein yield, percentage and yield of lactose, milk fat percentage, 4% FCM yield and SCC were similar ($P > 0.05$) for cows fed MEG and LIN. Compared to MEG, LIN increased concentrations (expressed as a percentage of total fatty acids) of C6, C8, C10, C12, C14:0, C14:1, C18:0, C18:3, and C20:5, and decreased those of C16:0, C16:1, C18:1, and C18:2. The non-return rate to first insemination was higher ($P < 0.05$) for cows fed LIN (89%) compared to those fed MEG (59%). The pattern of growth and growth of medium (6–9 mm), large (9.5–15) and dominant (>15 mm) follicles were affected by fat but not those of small follicles (3–5.5 mm). These data suggest that dietary fat modifies milk fatty acid composition and has an important effect on reproduction.

Key Words: Dairy Cattle, Fat, Reproduction

1181 Influence of feeding calcium protected fat on goats milk production and composition. F. T. Sleiman*, M. I. Baydoun, M. G. Uwayjan, M. T. Farran, I. G. Rubeiz, R. F. Khalil, and V. M. Ashkarian, *American University of Beirut, Lebanon.*

Nine lactating does averaging 74 days postpartum were used in a completely randomized design to test the effect of incorporating 0, 5 and 7% Ca-salts of palm oil in concentrate rations on milk yield and composition and milk fatty acid (FA) content. Each doe was allowed 1.1 kg concentrate (15.5% crude protein (CP)) and 3 kg of corn silage. Fat supplementation did not affect ($P > 0.05$) total dry matter intake (TDMI) and apparent digestibility of DM, CP, crude fiber, gross energy and acid detergent fiber. Similarly, milk yield, percentages of total solids (TS), solids-non-fat (SNF), SNF in TS, fat in TS and protein in milk were not ($P > 0.05$) affected. However, milk fat percentage increased ($P < 0.05$) with the 7% fat supplementation as compared to the control (4.5 vs 3.7%). Caproic acid (C6:0) of the butter fat did not change ($P > 0.05$) with fat addition, but caprylic-myristic (C8:0-C14:0) FAs decreased ($P < 0.05$). Palmitic acid (C16:0) increased linearly ($P < 0.05$) with the increase in the level of supplemental fat. A similar significant increase, ($P < 0.05$), was observed at the 5% fat level for the stearic, oleic and linoleic acids (1.5, 1.0 and 1.0g/100g, respectively) as compared to the control. It was concluded that ruminally inert supplemental fat of long chain fatty acids could influence the percentage of long chain fatty acids in the milk fat.

Key Words: Does, Calcium Protected Fat, Milk Fatty Acids

1182 A comparison of methods for transesterification of lipids from feedstuffs and rumen microorganisms. M. B. Whitney, D. C. Rule, B. W. Hess, J. E. Kaltenbach*, J. R. Erwin, and H. J. Harlow, *University of Wyoming, Laramie.*

The purpose of this experiment was to compare direct transesterification of feedstuffs and microorganisms using 14% boron-trifluoride in methanol with transesterification of solvent extracted lipids. Triplicate, .5 g samples of bromegrass hay, corn/soybean meal combination, and a total mixed ration (hay, corn, soybean meal) with 3% added soybean oil were analyzed for fatty acid composition by the two processes. The samples were subjected to chloroform/methanol extraction followed by transesterification with 14% boron-trifluoride in methanol at 80° C for 2 h (EXT), or direct transesterification with 14% boron-trifluoride in methanol at 80° C for 2 h (DIR). Fatty acid percentages are shown below. Weight percentages were of similar magnitude for either procedure. Very low error permitted detection of differences ($P \leq .01$) in weight percentages; however, not all fatty acids were consistently affected or favored by either procedure. The advantages of the DIR procedure are the elimination of organic solvents and fewer preparatory steps. Results indicate that the DIR procedure is an acceptable method for analysis of total fatty acids of feedstuffs and rumen microbes.

FA	Grass Hay			Corn/SBM			TMR+3%			Microbes		
	EXT	DIR	SE	EXT	DIR	SE	EXT	DIR	SE	EXT	DIR	SE
16:0	28.1	32.0	.26*	15.5	15.3	.16	14.9	15.2	.06	30.4	32.1	.05*
18:0	1.8	1.7	.06	2.5	2.2	.01*	3.9	3.5	.03*	45.3	41.4	.09*
18:1	5.7	6.7	.08*	23.6	22.5	.16*	19.6	19.1	.05*	13.7	13.4	.14
18:2	20.2	18.3	.24*	54.7	56.4	.31	48.5*	48.9	.09	4.8	5.9	.03*
18:3	42.0	38.1	.21*	3.1	3.1	.04	12.1	12.6	.07*	3.1	4.2	.01*

* ($P \leq .01$)

Key Words: Fatty Acids, Laboratory Techniques

1183 Influence of method of supplementation on the utilization of supplemental fat by feedlot steers. R. A. Zinn^{1*} and A. Plascencia², ¹University of California, El Centro, and ²Instituto de Investigaciones en Ciencias Veterinarias, UABC, Mexicali (Mexico).

Seventy-two Holstein steers (273 kg) were used in a 151-d feeding trial to evaluate the influence of method of fat supplementation on growth-performance. Dietary treatments consisted of 1) control diet (no supplemental fat), 2) 5% yellow grease (YG) on grain (YG was first mixed with a portion of the steam-flaked corn in the proportion 25% YG to 75% corn, prior to adding other dietary ingredients), and 3) 5% YG on ration (YG was added to the mixer as the next to the last step, prior to adding molasses). There were no treatment effects ($P > .10$) on ADG. The addition of 5% YG decreased (6.3%, $P < .01$) DMI, and increased feed efficiency (4.7%, $P < .01$) and diet NEg (5.7%, $P < .01$). There were no effects ($P > .10$) of method of fat supplementation on growth-performance. Six Holstein steers (313 kg) with cannulas in the rumen and proximal duodenum were used in a replicated 3 X 3 Latin square design experiment to evaluate treatment effects on digestive function. There were no treatment effects ($P > .10$) on ruminal digestion of starch or N. Supplemental YG decreased ruminal digestion of OM (10.4, $P < .01$) and ADF (36.7%, $P < .10$). There were no treatment effects ($P > .10$) on post-ruminal digestion of OM, starch, ADF and lipid. However, saturating a portion of the grain with fat decreased slightly (2.7%, $P < .10$) post ruminal digestion of N. Supplemental YG decreased ($P < .10$) total tract digestion of OM (1.8%) and ADF (13.9%). It is concluded that there are no positive associative effects of adding YG directly to steam-flaked corn on growth-performance or digestive function.

Key Words: Fat, Metabolism, Dry Lot Feeding

1184 The effects of high oleic acid corn grain or soybeans on milk composition in mid-lactation Holsteins. C. M. Luhman^{1*} and P. Feng², ¹Land O'Lakes Research Farm, Webster City, IA and ²Dupont Agricultural Products, Des Moines, IA.

Forty Holstein cows ranging from 120 to 250 days in milk were allotted by parity, production, and days in milk to one of four treatments (10 cows per treatment): 1) control, no added fat, 2) 16.9% DM roasted high oleic soybeans (HO soybeans), 3) 16.9% DM roasted mill run soybeans (soybeans), 4) 33.7% DM high oleic corn (HO corn). The objectives of the trial were to determine the ability of oleic acid from high oleic soybeans or high oleic corn to transfer intact oleic acid into milk fat and to produce butter from milk fat of the treated cows to examine for softness and fatty acid composition. The ration forage base was 50:50 alfalfa haylage:corn silage. Results were:

Item	Control	HO Soybean	Soybeans	HO Corn
DMI, kg	22.9 ^a	23.0 ^a	21.2 ^b	22.6 ^a
Milk, kg	38.4 ^a	39.0 ^a	38.9 ^a	36.8 ^b
4% FCM, kg	36.5 ^a	39.0 ^b	35.9 ^a	36.5 ^a
Milk fat, %	3.20 ^a	3.51 ^b	3.02 ^a	3.44 ^b
Milk protein, %	3.02 ^a	3.06 ^b	2.91 ^a	3.03 ^a
C16:0, mg%	32.2 ^a	23.8 ^c	26.5 ^b	28.9 ^b
C18:1 cis, mg%	16.9 ^a	26.5 ^c	20.1 ^b	19.9 ^b
C18:1 trans, mg%	0.16 ^a	0.38 ^c	0.26 ^{bc}	0.23 ^{ab}
C18:2, mg%	2.22 ^{bc}	1.78 ^c	4.61 ^a	2.71 ^b

Solid fat indices and penetration scores indicated that milk fat from fed HO soybeans was softer than fat from all other treatments. Fat from cows fed HO corn was equivalent to fat from cows fed control. HO soybeans are successful in altering milk fat to a greater extent than HO corn or mill run soybeans.

Key Words: Oleic, Soybeans, Milk Production

1185 Effects of feeding bakery waste on performance and meat quality in crossbred beef steers. P. J. Guioy*, D. G. Fox, D. H. Beeraman, and D. J. Ketchen, Cornell University, Ithaca, NY.

A feeding trial was conducted with 120 Angus based steers to determine effects on performance and meat quality when 75% of whole corn grain was replaced with bakery waste in a high energy finishing diet. Chemical analysis of each diet ingredient and *in vitro* rates of digestion from gas production of bread and corn were determined to provide accurate information for ration evaluations using the 1996 Beef NRC Model level II. Bakery waste contained 16% CP (75.6% degradable), and 75.1% NSC (70% as starch, which had a digestion rate of 16%/h). The steers were given one Synovex implant and started on experiment at 15 mo. of age and an average weight of 367 kg. Twenty steers per treatment were individually fed to evaluate allocation of pen DMI to individuals. The cattle were commercially slaughtered in three groups (40 steers at 101, 60 steers at 126, and 20 steers at 160 d on feed) weighing an average of 553 kg when they reached a small degree of marbling. Warner-Bratzler shear force values were measured in rib steaks at 5, 14 and 21 d after slaughter (n = 76). Rib steaks from 30 steers per treatment were evaluated for palatability traits. Use of bakery waste at 55% of the diet significantly improved feed efficiency 10%. There were no statistically significant differences between the two diets for effects on average daily gain, carcass characteristics, shear force values and sensory panel ratings of tenderness, juiciness, flavor and overall acceptability. After adjusting intestinal starch digestibility in level II to 63% for the whole corn and 90% for the bakery waste, predicted ADG matched that observed. Apparent NEg values for bakery waste and corn were 1.57 and 1.41 Mcal/kg respectively.

Diets	ADG, kg	DM/kg Gain	Quality Grade ^a	Yield Grade	Shear Force d 5, kg	Shear Force d 24, kg	Panel Panel Acceptability ^b
Bakery Waste	1.5	6.6	4.8	3.3	4.9	4.0	5.2
Corn	1.6	7.3	4.9	3.5	4.7	4.0	5.2
<i>P</i>	NS ^c	< .001	NS	NS	NS	NS	NS

^a4.0 = Select; 5.0 = Choice -

^b8-point scale, 1 = unacceptable, 8 = extremely desirable

^cNS = not statistically significant ($P > .1$)

Key Words: Bakery Waste, Feed Efficiency, Meat Quality

1186 Nutritive value of silages containing cannery byproduct for feedlot cattle. H. W. Harpster*, R. L. Swope, E. H. Cash, J. W. Comerford, and V. H. Baumer, The Pennsylvania State University, University Park.

Ten beef-breed crossbred steers (292.5 kg) were individually fed one of three silage-containing diets: corn silage (CS); food waste/ground hay (FW/H); and food waste, chopped corn stalks (FW/S). FW consisted of ground, filter-pressed potato and carrot cannery residues (15–20% DM), 90% IVDMD) and was combined with H or S and ensiled in large silage bags. Post-ensiling values for FW/H and FW/S were: DM, 33.7 and 32.0%; pH, 4.58 and 4.78; CP (% of DM), 9.13 and 7.16; and ADF (% of DM, 32.6 and 40.2. Initially each silage was fed at approximately 60% of the total ration DM, the remainder being cracked corn, soybean meal, (isonitrogenous diets) and a mineral/vitamin mix containing lasalocid sodium. Later in the feeding period, the proportions were reversed. Steers were weighed every 28 days and ultrasound scanning techniques were utilized to select the fattest steers in each treatment group, with 3, 3, and 4 steers per treatment slaughtered at 168, 196, and 224 days on feed. There were no treatment by slaughter group interactions for any criteria ($p > .05$). At 168 days on feed, least-square means for CS, FW/H, and FW/S steers were: DMI (kg/hd/d), 11.14^a, 9.83^b, 9.18^b; ADG (kg/hd/d), 1.82^a, 1.48^b, 1.36^b; and gain/feed .162, .155, .146 (a, b $p < .05$). Across all slaughter groups respective values were: external fat thickness (cm), 1.12^a, 0.81^b, 0.69^b; marbling score (slight=400, small=500), 490^a, 424^b, 431^b; yield grade, 3.1^a, 2.7^b, 2.5^b; and hot carcass weight (kg), 836^a, 754^b, 708^b. There were no differences ($p > .05$) in lean firmness, lean color, or ribeye area. Byproduct silages appeared to have 75–80% of the value of whole plant CS in these feedlot rations.

Key Words: Beef, Byproduct, Carcass Characteristics

1187 Soybean hulls as a roughage-free diet for limit-fed growing cattle. C. A. Loest*, E. C. Titgemeyer, J. S. Drouillard, D. A. Blasi, and D. J. Bindel, *Kansas State University, Manhattan.*

Heifers (n=300; 260 kg initial BW) were used in a complete block design to compare growth over 98 days of cattle fed roughage-free diets based on soybean hulls or fed roughage- or corn-based diets, and to determine if cattle fed soybean hull-based diets would respond to methionine hydroxy analogue (MHA), ruminally protected betaine, or concentrated separator byproduct (CSB; a source of betaine). There were 4 to 6 heifers per pen and 6 pens per treatment. Treatments included 1) a roughage-based diet fed at 2.75% of BW (ROUGH), 2) a corn-based diet fed at 1.5% of BW (CORN1.5), 3) a corn-based diet fed at 2.25% of BW (CORN2.25), 4) a soybean hull-based diet fed at 1.5% of BW (SH1.5), 5) a soybean hull-based diet fed at 2.25% of BW (SH2.25), 6) SH1.5 plus 11.4 g/head daily MHA, 7) SH2.25 plus 11.4 g/head daily MHA, 8) SH2.25 plus 7 g/head daily rumen-protected betaine, and 9) SH2.25 plus 250 g/head daily CSB. Supplemental MHA, betaine, and CSB did not change DMI, gain, or gain:feed for cattle fed soybean hulls. DMI (6.35 vs 6.53 kg/d) was similar for heifers fed SH2.25 and CORN2.25, but heifers fed SH2.25 gained 27% less weight (.78 vs 1.06 kg/d; P<.01) and were 25% less efficient (.122 vs .163; P<.01). Similarly, DMI (4.12 vs 4.22 kg/d) was not different for cattle fed SH1.5 and CORN1.5, but cattle receiving SH1.5 had lower gains (.38 vs .51 kg/d; P<.02) and gain:feed (.092 vs .122; P<.01). Cattle receiving ROUGH had gains (.82 kg/d) similar to SH2.25, but gained 23% less (P<.01) than heifers fed CORN2.25. DMI for ROUGH (7.63 kg/d) was higher than for all other treatments. Gain:feed for ROUGH (.107) was less (P<.01) than CORN2.25, tended (P<.13) to be lower than SH2.25 and CORN1.5, but greater (P<.01) than SH1.5. Soybean hulls can be limit-fed to growing cattle. Gains of cattle fed soybean hull-based, roughage-free diets were less than those fed similar amounts of a corn-based diet, but gains and efficiencies of heifers fed the soybean hull-based diet at 2.25% BW were comparable to heifers fed a roughage-based diet at 2.75% BW.

Key Words: Soybean Hulls, Heifers, Growth

1188 Methane loss and metabolizable energy value of fibrous grain by-product feeds. M. J. Jarosz* and D. E. Johnson, *Colorado State University, Fort Collins.*

The objective of this study was to determine fecal, urinary, and methane losses from dried brewer's grains (BREW), dried distillers grains (DIST), and dried corn gluten feed (CGF), with a 7-day digestion trial concomitant with open-circuit respiration calorimeter. Six crossbred steers (310 kg) were fed each by-product in a 3X3 latin square with intake level randomly assigned within diet. Experimental feeds were fed with 20% chopped alfalfa and by-product values determined by difference using fixed alfalfa values determined in a separate trial. BREW and DIST had significantly (p<.01) less CH4 production than CGF. Urinary energy losses were also higher (p<.05) for CGF. The ME averaged for both levels of intake for BREW, DIST, and CGF were 2.79, 3.31, and 3.15 Mcal/kg, respectively. Higher levels of intake suppressed ME values (p<.05) from 5 to 9%.

Level of intake	BREW		DIST		CGF		SEM
	low	high	low	high	low	high	
GE, Mcal/BW ^{.75}	261.8	355.4	306.6	329.4	201.9	337.9	29.0
DE, % ^{a,b}	66.2	60.9	74.2	73.5	83.3	75.1	3.0
UE, % ^a	2.4	2.2	2.2	2.5	3.1	3.2	.3
CH ₄ E, % ^{ab}	3.3	2.8	2.3	2.4	5.7	4.0	.5
ME, % ^{ab}	59.7	55.7	69.5	65.7	74.2	67.8	2.5
ME, Mcal/kg DM ^{ab}	2.96	2.63	3.61	3.03	3.24	3.07	.1

^aDiet effect (p<.05); ^bLevel of intake effect (p<.05).

Key Words: Beef Cattle, By-products, Methane

1189 Effects of corn and sorghum distillers grains on performance and carcass characteristics of finishing steers. K. C. Fanning*, C. T. Milton, T. J. Klopfenstein, and M. J. Klemesrud, *University of Nebraska-Lincoln.*

Sixty crossbred, yearling steers (BW = 360 ± 5.3 kg) were used in a completely randomized designed experiment to compare distillers grains produced from either corn or sorghum grain in finishing diets. The control diet (CON) contained 86% dry-rolled corn, 7.5% alfalfa hay, 3.5% molasses and 3% supplement (DM basis). All diets were formulated to contain a minimum of 12.5% CP, 6.8% DIP, .7% Ca, .3% P and .6% K. Distillers grains produced from corn (CD) or sorghum (SD) grains were fed at 30% of the dietary DM, replacing dry-rolled corn. There was a 17 d, four diet adaptation period for adjustment to the finishing diet. Steers were implanted with Revalor[®] and individually fed experimental diets for 127 d. Final weights were calculated using carcass weights adjusted to a common dressing percentage (63%). Orthogonal contrasts were used to compare CON vs the average of CD and SD, and CD vs SD. Dry matter intake was higher (P < .05) for steers fed SD compared with CD, and tended to be higher (P = .12) than CON. Compared with CON, steers fed CD or SD gained 9.8% faster (P < .01; 1.65 vs 1.83) and were 8.2% more efficient (P < .01; .156 vs .170). Daily gain and gain efficiency (G/F) were similar between CD and SD. Carcass weights were 14 kg heavier (P < .05) for steers fed SD or CD than those fed CON. Compared to CON, feeding SD or CD increased 12th rib fat (P < .01) and yield grade (P < .10), and those fed SD had more (P < .10) 12th rib fat than those fed CD. Dressing percentage, longissimus muscle area, marbling, and the percentage of carcasses grading Choice were unaffected by treatment. Based on performance, distillers grains produced from corn or sorghum grains are similar in energy concentration. The calculated NEg value for corn and sorghum distillers grains was 34% greater than dry-rolled corn.

Key Words: Cattle, Distillers Grains, Feedlot

1190 Value of alternative ingredients in calf growing rations. M. H. Poore*, G. M. Gregory, J. L. Hart, and P. R. Ferket, *North Carolina State University, Raleigh.*

This 79-day study evaluated common byproducts in backgrounding rations. The control ration (C) contained 21% cottonseed hulls (CSH), 21% bermudagrass silage (BGS), 47% ground corn (GC) and 10% soybean meal (SBM) on a dry basis and was balanced to provide crude protein, energy and minerals for .91 kg/day gain. Peanut hulls (PH) or textile mill waste (TXT) were substituted directly for CSH; broiler litter (BL) was substituted for GC, SBM and CSH; whole cottonseed (WCS), or soybean hulls (SH) were substituted for GC and SBM; and whole corn (WC) or fermented sweet potatoes (SWT) were substituted for GC giving a total of 8 treatments. There were nine individually fed heifers per treatment, and the alternative feeds composed 21, 21, 13, 15, 25, 47 and 15% of diet dry matter for PH, TXT, BL, WCS, SH, WC and SWT diets, respectively. Prices used were 125, 200, 25, 65, 25, 25, 75, 85, 110 and 20 \$/909 kg (as fed) for GC, SBM, BGS, CSH, PH, TXT, BL, WCS, SH, WC, and SWT, respectively. Each diet was compared to the control using single degree of freedom contrasts. Dry matter intake was lower for SWT as compared to C (P<.11), and averaged 9.5, 10.0, 8.7, 9.9, 9.3, 9.6, 9.5, and 8.5 kg/day for C, PH, TXT, BL, WCS, SH, WC and SWT, respectively. Average daily gain was lower for TXT than C (P<.10) and averaged .94, 1.0, .81, .94, .95, .97, .92, and .94 kg/day for C, PH, TXT, BL, WCS, SH, WC and SWT, respectively. Return over feed cost (\$/head) was higher for SWT (P<.11) and SH (P<.07) as compared to C and averaged 10.0, 19.32, 10.2, 16.1, 20.1, 25.4, 13.9, and 23.9 \$/head for C, PH, TXT, BL, WCS, SH, WC and SWT, respectively. Realized value (break even price) of ingredients given our cost for GC, SBM and CSH, was 72, 26, 69, 150, 152, 119, and 43 \$/909 kg for PH, TXT, BL, WCS, SH, WC and SWT, respectively. Substituting SH for GC increased (P<.05) acetate:propionate ratio from 3.55 to 4.80. This study showed there is potential for using each of these ingredients in mixed rations, and supports their use to improve economic returns, depending on ingredient prices.

Key Words: Beef Cattle, Byproducts, Mixed Diets

1191 Use of soyhulls in broiler-litter based diets fed to beef cattle. N. K. Gurung* and D. L. Rankins, Jr., *Auburn University, AL*.

Soyhulls have been used as a supplement for cattle consuming forage-based diets without negative effects on forage intake and digestibility. It would appear that they have potential for use in broiler litter-based diets. Thirty-two steers (initial BW 276 ±16 kg) were allotted randomly to one of four diets (4 steers/pen; 2 pens/diet): 1) 53% cracked corn and 47% litter (DM basis), 2) 47% litter, 40% cracked corn, and 13% soyhulls, 3) same as diet 2, and 4) 47% litter, 26.5% cracked corn, and 26.5% soyhulls. All diets were fed *ad libitum*. Diets 1, 3, and 4 were supplemented with 1.5 kg of chopped bermudagrass hay per steer per d. Steers were fed for 112 d. Upon completion, four steers from each diet were placed in individual stalls for determination of nutrient digestibilities. Samples were taken for 7 d. The following statistical comparisons were made: hay vs no hay, linear and quadratic effect of soyhull addition. Total DMI was increased by hay supplementation ($P < .05$). Likewise, hay supplementation increased ADG ($P < .05$) and soyhull addition increased ADG in a linear manner ($P < .05$). Hay supplementation did not effect nutrient digestibilities ($P > .05$). Soyhull addition had a quadratic effect on DM, OM, GE, NDF, ADF, and CP digestibilities ($P < .05$). Given the cost of soyhulls versus corn, soyhull addition to litter-based diets is a viable option. Hay should be fed even when soyhulls are used in litter-based diets.

Key Words: Beef Cattle, Broiler Litter, Soyhulls

1192 Evaluation of various roughage sources for beef cattle consuming broiler-litter based diets. D. L. Rankins, Jr.* and N. K. Gurung, *Auburn University, AL*.

Cattle consuming litter-based diets require some form of roughage for optimal weight gain. Amount and quality of roughage have not been studied adequately. Two trials were conducted. Trial 1. Forty-eight steers (initial BW 200±13 kg) were allotted to one of four diets (4 steers/pen; 3 pens/diet): 1) 53% cracked corn and 47% litter (DM basis) fed free-choice, 2) diet 1 + daily hay at .5% of BW, 3) diet 1 + hay fed on Mondays and Thursdays to equal .5% of BW, and 4) diet 1 + free-choice hay. Total DMI was greater ($P < .05$; 7.2, 9.1, 8.2, and 9.8 kg/d respectively for diets 1 through 4) by steers fed hay *ad libitum* or on a daily basis than steers offered no hay. Feeding hay twice per wk resulted in DMI that was not different from any other method ($P > .05$). Daily gains were greater ($P < .05$; .88, 1.22, .96, and 1.30 kg/d, respectively, diets 1 through 4) for steers consuming hay *ad libitum* or on a daily basis than steers that were offered no hay or twice per wk. Trial 2. Fifty steers (initial BW 271±17 kg) were allotted to one of five diets (5 steers/pen; 2 pens/diet): 1) 53% cracked corn and 47% litter (DM basis) fed free-choice, 2) diet 1 + daily hay at .5% of BW, 3) 47% corn, 42% litter, and 11% peanut hulls (DM basis) fed free-choice, 4) diet 1 + free-choice hay, and 5) diet 1 + free-choice hulls. Total DMI was greatest in steers fed free-choice hulls and hay ($P < .05$) and lowest in those fed no roughage ($P < .05$; 8.7, 10.2, 10.0, 11.6, and 11.5 kg/d, respectively for diets 1 through 5). Daily gains were slowest in steers fed diet 1 (.96 kg/d) while those fed diets 2, 4, and 5 (1.23, 1.31, and 1.17, respectively) had the fastest ADG. Feeding free-choice roughage resulted in the best performance by steers fed litter-based diets. Source of roughage should be based on economics.

Key Words: Beef Cattle, Broiler Litter, Roughage

1193 Growth performance and feed efficiency of lambs fed diets containing extruded whole cottonseed as the source of dietary protein and roughage. S. P. Jackson, *Texas Tech University, Lubbock*.

The objective of this study were to compare a lamb finishing diet that contained extruded whole cottonseed as the source of protein and roughage with a traditional control finishing diet that contained cottonseed meal and cottonseed hulls as the protein and roughage sources. The average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency were measured during a 6-week growth trial. Rambouillet wethers ($n = 36$) weighing approximately 40 kg were randomly divided into six groups of six lambs. The control diet utilized cottonseed hulls (CSH) as the dietary roughage source and soybean meal (SBM) as the primary source of protein. The extruded diet was formulated to replace the CSH and SBM in the control diet with extruded whole cottonseed. Vegetable fat was added to the control diet to insure that each diet was both isocaloric as well as isonitrogenous. Each diet was fed to three pens of six lambs. Average daily gain (kg/hd/d) was similar ($P = .23$) for lambs on both diets (Control Diet, .29; Extruded Diet, .26). Average daily feed intake did not significantly between diets. Feed efficiency (gain:feed) was not different ($P = .5$) between lambs fed the control (.19) or extruded (.18) diet. This study shows that extruded whole cottonseed can be used effectively in lamb finishing diets without negatively affecting animal performance.

Key Words: Sheep, Growth, Whole Cottonseed

1194 Performance of goats fed varying levels of whole cottonseed. J-M. Luginbuhl*, M. H. Poore, and A. C. Parsons, *North Carolina State University, Raleigh*.

The objective of this study was to determine the level of whole cottonseed (WCS) that could successfully be included in diets for growing male goats. Thirty-six Boer and Boer-Brush cross kids (avg initial wt 21 ± .5 kg) were used in a completely randomized design to study the effects of increasing level of WCS on performance, intake, digestibility and live grade. Animals were stratified by weight and assigned to one of four diets containing 0, 8, 16, or 24% WCS. All diets contained 71% chopped orchardgrass hay; WCS replaced corn and soybean meal to maintain calculated TDN at 68% and CP at 15%. Calculated NDF concentrations in the diets were 52, 55, 59 and 62%. The Ca:P ratio was maintained at 2:1, and animals were given *ad libitum* access to feed. A subgroup of 16 purebred animals was used to determine live grade and for digestibility calculations using total 5-day orts and fecal collection. Over the 91 d performance phase, DMI (808, 775, 791, 672 g/d; $P < .05$) and ADG (99, 88, 83, 67 g/d; $P < .01$) decreased linearly with increasing WCS in the diet. Addition of WCS to the diet resulted in linear and quadratic decreases in DM (73, 72, 73, 67%; $L: P < .02$, $Q: P < .1$) and NDF (70, 70, 71, 65%; $L: P < .05$, $Q: P < .07$) digestibility. Live grades were prime for 13 animals (81%) and choice for 3 animals (19%), with no trend between treatment. Adding WCS to diets for growing goats had detrimental effects on animal performance, and levels higher than 16% cannot be recommended due to large depressions in intake, gain and digestibility.

Key Words: Goats, Cottonseed, Performance

1195 Response of lactating Jersey cows to whole fuzzy cottonseed coated with gelatinized corn starch. J. K. Bernard*, *University of Tennessee, Jackson.*

Coating whole fuzzy cottonseed (WCS) with corn starch greatly improves their handling characteristics. In a previous trial, cows fed WCS coated with 5% gelatinized corn starch or starch plus 10% multi-dextrin sugar tended to have higher DMI and milk yield compared to feeding WCS. Milk fat percent was depressed when WCS coated with starch and sugar was fed. This trial was conducted to determine the effect of feeding WCS coated with 2.5% gelatinized corn starch on the performance of Jersey cows. Thirty-six cows averaging 160 ± 39 DIM were assigned to one of two groups by milk yield and parity in the 8 wk switch back trial. The trial was divided into two experimental periods. The first 2 wk in each period was for ration adjustment with sample collection during the last 2 wk. Treatments were assigned randomly to each group at the beginning of the trial and reversed at the end of the first period. Cows were fed a total mixed ration daily behind Calan doors containing (DM basis) 10.2% mixed hay, 45.2% corn silage, 15.0% WCS or coated WCS, and 29.6% concentrate. Dry matter intake, milk yield, percent milk fat, and percent milk protein was not different among treatments ($P > 0.10$) and averaged 15.9, 19.4, 4.70, and 3.65; and 16.2 kg/d, 19.3 kg/d, 4.62%, and 3.66% respectively for WCS and coated WCS. Whole fuzzy cottonseed coated with gelatinized starch is equal to uncoated WCS for supporting milk production.

Key Words: Cottonseed, Milk Production, Intake

1196 Effect of coating whole fuzzy cottonseed with starch or starch and sugar on fermentation products. J. K. Bernard¹ and S. A. Martin*², ¹*University of Tennessee, Jackson* ²*University of Georgia, Athens.*

Previous research showed that milk fat percent was depressed when whole fuzzy cottonseed (WCS) coated with starch and sugar was fed to lactating dairy cows. Therefore, an in vitro study was conducted to examine fermentation of WCS coated with starch or a combination of starch and sugar by mixed ruminal microorganisms. The completely randomized design trial included three treatments (WCS, WCS coated with 5% gelatinized corn starch [WCS+5S], or 5% gelatinized corn starch plus 10% maltodextrin sugar [WCS+SS]). Four concentrations (0, 0.4, 0.8, and 1.2 g) of each cottonseed source were used. Ruminal fluid was collected from a steer fed 6.8 kg of forage and 2.3 kg of concentrate supplemented once daily, and mixed ruminal microorganisms were incubated in anaerobic media (40 mL) that contained 20% (vol/vol) ruminal fluid in batch culture for 24 h at 39 C. All fermentations were performed on duplicate days with two replicates per day ($n=4$). Final pH values were 6.58, 6.43, and 6.35 for WCS, WCS+5S, and WCS+SS. Concentrations of total VFA, acetate, and L-lactate were greater ($P < 0.01$) with coated cottonseed compared with WCS. Propionate concentrations were lowest ($P < 0.01$) for WCS, intermediate for WCS+5S, and highest for WCS+SS. These results suggest that the observed depression in milk fat percent in the production trial was most likely due to the increased production of volatile fatty acids, especially propionate, and decreased pH when WCS+SS was fed.

Key Words: Cottonseed, VFA, Rumen

1197 Effects of whole cottonseed and low dose bST on milk production and reproduction of early postpartum dairy cows. A. L. Adams*, C. R. Staples, H. H. Van Horn, D. Ambrose, T. Kassa, W. W. Thatcher, C. J. Wilcox, and C. A. Risco, *University of Florida, Gainesville.*

During the cool season (October to May), whole cottonseed (WCS) and bovine somatotropin (bST) effects on milk production and reproduction were evaluated. Primi- and multiparous Holstein cows ($n=186$) were assigned at parturition to control diet (0% WCS), WCS fed at 15% of diet DM, 0% WCS + bST (208 mg/14 d), and 15% WCS + bST. First injection of bST was within 7 d pp. All cows received a timed insemination protocol (TI) for first service at 70 d pp and again at 116 d pp if not pregnant to first service. Subsets of cows were selected to analyze treatment effects on plasma glucose, urea N, triacylglycerides, and HDL-cholesterol ($n=60$); and for plasma progesterone and ovarian follicular dynamics by ultrasound ($n=28$) during the first TI. Milk production was greater (0.8 kg/d) and more persistent for cows fed WCS while cows receiving bST peaked at higher production. Milk protein percentage was unchanged by WCS. Feeding WCS increased milk fat percentage compared to control diet (3.45 vs. 3.15%). Whole cottonseed increased PUN (16.4 vs. 13.7 mg/dl), glucose (66.0 vs. 60.5 mg/dl), and HDL-cholesterol (107.4 vs. 83.5 mg/dl). Bovine somatotropin increased HDL-cholesterol (99.4 vs. 91.5), but decreased PUN (13.1 vs. 13.7 mg/dl) compared to control cows ($p < 0.01$). No interactions were noted between WCS and bST. Plasma progesterone concentrations were greater immediately prior to PGF_{2 α} administration for groups receiving WCS compared to control diet groups (11.6 vs. 7.1 ng/ml). Recruitment of class two follicles was greater for cows receiving WCS plus bST, whereas recruitment in response to bST was reduced in the absence of WCS. No effect of treatment was noted for pregnancy rate for first service (34.4%) second service (28.6%) or total pregnancy by 119 d pp (50.8%). However, an interaction of treatment x parity x month ($p = .08$) suggested a pregnancy advantage of using low doses of bST starting early postpartum in primiparous animals calving during warm months.

Key Words: Fat, Somatotropin, Reproduction

1198 Assessment of feeding management practices for beef and dairy cattle; Historical perspectives and application of research on feeding management. D. C. Weakley* and L. F. Reutzel, *Purina Mills, Inc., St. Louis, MO.*

The historical progression of published research in nutritional and feeding management in the past two to three decades has been driven primarily by socio-economic changes in both the production and research environments. The production segment has been shaped by extensive enterprise consolidation and consumer demands in food quality, which have resulted in drastic changes in the management of animals, feeding and finances. In turn, these forces have changed the nature of nutritional research from more basic pursuits in nutritional physiology to one of more immediate and applied pursuits in affecting the composition and efficiency of end product production. Research in feed additives has exploded in response to desires by producers to enhance the ease and efficiency of production in the face of challenges presented by expanding enterprises. The research segment, also, has been shaped extensively by socio-economic forces. Decreasing financial support has significantly reduced the research infrastructure in both the industry and academic segments. The consequence has been a greater dependence by academic researchers on industrial financial support, resulting in a shift in the direction of nutritional research. At the same time, the consolidation in the producer segment has resulted in a smaller pool of agriculturally grounded graduate students from which to support human resource needs to maintain academic research programs. This, along with a greater dependence on past research findings in basic nutritional physiology, has resulted in a greater use of mathematical modeling of biological functions, in an attempt to provide ways to improve efficiency of animal production. The need for a better description of post-absorptive nutrient metabolism in these models has expanded this research segment. Due to less available resources, future research efforts must be more specifically directed to improving the efficiency and quality of animal production, while addressing the changing needs of a consolidating animal industry.

Key Words: Feeding Management, Animal Nutrition, History

1199 Feeding management for beef cattle. R. H. Pritchard, *South Dakota State University, Brookings.*

The concern to optimize the feeding management of manger fed cattle has prompted much research by lay and professionals. Focus areas have included frequency of feed deliveries; variability in quantity or timing of feed deliveries; and controlling access to feed by limit or restricted feeding, full feeding, and use of self-feeders. Technologies such as timed operation mechanical feeders have been developed. Chemical limiters of intake ranging from NaCl to combinations of nutritive and nonnutritive additives have been used. While these approaches are an attempt to provide for cost effective animal husbandry, there is an underlying dichotomy of objectives in that generally we expect to increase biological efficiency by increasing DMI and the fermentability of feeds; but this must be done while preventing overloads of fermentable carbohydrates. Today most cattle are fed in large commercial feedlots. The logistical challenges of delivering feed to large numbers of cattle while controlling overhead costs have dictated feeding strategies that may not be ideal for the cattle themselves. Change occurs slowly in these systems, in part because of the variable research results published regarding feeding management. A clear challenge to the research community is to resolve discrepancies in results of feed management research which may be caused by interactions between factors associated with the diet, the behavioral and physiological tendencies of the animal, and its environment. We will be challenged by animals whose growth potential exceeds the production potential of the rumen under prevailing nutrition and management practices. Feedstuffs are increasingly moving toward specialty feeds (e.g., high oil corn) and to by-products of other industries. We are only beginning to realize fully the challenge of managing the increased chemical instability and variability inherent in many of these feeds. There will be an increased need to be able to program the rate and composition of growth to meet expectations of an evolving branded beef product business. The trend toward privatizing of this type of research will complicate the sharing of information that can catalyze progress.

Key Words: Feed Management, Beef Cattle, Feedlot

1200 Some perceptions of research needed in feeding management of dairy cattle. C. E. Coppock*, *Coppock Nutritional Services, Laredo, TX.*

My objectives are to suggest 3 areas of needed research with application to applied nutrition and feeding.

1. Rations formulated to support very high milk production result in minimal fiber with the attendant risk of acidosis and the resultant health disorders which accompany this serious malady. It has been recommended to offer sodium bicarbonate free-choice to high-yielding cows fed energy dense rations so that they may consume this buffer to alleviate any acidosis. It has also been stated that offering salt blocks for cows to lick, will increase salivation which in turn will increase ruminal pH.

2. Relative Feed Value is an index used widely to characterize the quality of forages, especially grass and legume hays. This index is based on acid detergent fiber and neutral detergent fiber. However, additional value would be possible if such an index included crude protein and perhaps other laboratory measurements. Additional accuracy would be possible if separate indexes were used for legumes and grasses.

3. There is a trend toward the use of nutritional stratagems to strengthen the immune system of cattle. This allows a reduction in the use of antibiotics and other medications to treat various disorders. Ascorbyl-2-polyphosphate has been described as a rumen stable source of ascorbic acid. Supplementation with ascorbic acid of diets for calves has strengthened their immune response. Because another antioxidant, vitamin E, has improved the immune response of adult cows, research is needed with vitamin C or a derivative, to show its value to the high-yielding dairy cow.

Research results which are conclusive will have immediate benefit in feeding management.

Key Words: Free-Choice Sodium Bicarbonate, Relative Feed Value, Vitamin C

1201 Interpretation and Design of Non-Regulatory On-Farm Feeding Trials. L. R. Jones¹, N. St-Pierre², J. Siciliano-Jones¹, and R. D. Muller³, ¹*F.A.R.M.E. Institute, Inc., Homer, NY*, ²*The Ohio State University, Columbus*, and ³*Elanco Animal Health.*

Non-regulatory feeding trials are used to determine the frequency and magnitude of response to a treatment. This is important to determine the odds of success, factors that influence the success, and potential economics of the practice. These types of trials are not appropriate for elucidating mechanisms or modes of action. Correct experimental design is critical. Four factors impact the validity of these trials: animal randomization, confounding with time, identification of the proper experimental unit, and adequate replication. Animals should be assigned to treatment without a systematic influence of environmental or physiological factors. The response of interest is often time related and will be influenced by environmental conditions. The experimental design must account for and remove these influences. The experimental unit is the smallest entity to which the treatment is applied randomly. In commercial settings, this is often a pen of animals. The number of experimental units to be used should be determined from the desired power, and Type I and II error rates. Trials that have little chance of detecting the expected response are not worth conducting. Although measurements may be taken on an individual animal basis, in a pen feeding situation, the experimental unit is the pen. Frequency of data collection generally does not influence the treatment effect; however, it does influence the variance associated with the observations and the power to detect differences in treatments. Statistical methods that account for repeated observations over time are required when analyzing data with multiple observations on the same animal. Improper accounting for environmental changes over time is the most common error. Other errors include improper assignment of animals to treatment, failure to replicate the treatment across multiple experimental units, lack of on-farm oversight, and poor calibration of test equipment.

Key Words: Statistical Designs, Trials

1202 Assessment of the true digestible energy in feedstuffs from ruminal and postruminal incubation in dacron bags. A. Arieli*, K. Shachar, S. J. Mabjeesh, S. Zamwell, and D. Sklan, *Faculty of Agriculture, The Hebrew University, Rehovot, Israel.*

The digestible energy (DE) in feedstuffs was assessed from the combined estimates of ruminal and postruminal digestion obtained by the rumen bag and mobile bag techniques. Samples of concentrates (corn, barley and sorghum grains), roughages (corn and wheat silages, vetch hay and wheat straw) and protein supplements (soybean and sunflower meals) were placed in dacron bags in the rumen of 3 lactating dairy cows for eight time periods, from 3 to 72h. Postruminal digestion of residual feeds was estimated in 1-2 cows using the samples after rumen degradation on 12 h incubation. Concentrations of DM, organic matter, neutral detergent fiber (NDF), nonstructural carbohydrates and CP were determined in original feedstuffs, and in residues of ruminal and postruminal incubation. The DE in feedstuffs were calculated from the sums of the effective ruminal degradability of carbohydrates and proteins, and from the postruminal digestibility of carbohydrates, proteins and fats, multiplied by the corresponding nutrient's gross energy values. Mean post ruminal DE among the feedstuffs were 33, 38 and 41% of total tract DE, for rumen outflow of 4, 6 or 8% per h. However, rumen outflow had only a minor effect on total tract DE. There was a close correlation (r^2 0.92, SE 200 Mcal/kg of DM, $P < 0.001$) between the combined bag estimated DE and the corresponding NRC values in similar feed ingredients. A significant correlation was found also between NDF content and bag estimated DE in feedstuffs (r^2 0.82, SE 410 Mcal/kg of DM, $P < 0.001$). Overall, combined bag based estimations were about 5% higher than NRC table values. The combined bag technique is relatively simple method for determining the true DE of ruminant feedstuffs.

Key Words: Dacron Bags, Digestible Energy, Feedstuffs Evaluation

1203 Diet and animal differences affect *in situ* digestion kinetics. D. R. Mertens*¹, P. J. Weimer¹, and G. M. Waghorn², ¹*U.S. Dairy Forage Research Center, Madison, WI*, ²*AgResearch Grasslands, Palmerston North, N.Z.*

Digestion kinetics may provide information that is useful in formulating rations. The objective of this project was to evaluate the effects of the animal and its diet on *in situ* digestion kinetics of dry matter and fiber. Four dairy cows in midlactation were used in a balanced 4X4 Latin square design with a factorial arrangement of treatments (2 fiber sources X 2 fiber levels). Diets containing alfalfa or corn silage with either 24 or 32% aNDF (amylase-treated NDF) were fed twice daily during four week periods. Alfalfa silage, corn silage, cotton fiber, corn grain, and soybean meal were incubated *in situ* for 0, 3, 5, 9, 15, 24, 30, 36, 48, 72, or 96 h. Forages were coarsely ground and incubated in large dacron bags. Concentrates were ground and incubated in small bags. Bags were inserted after the morning feeding and incubated during the last week of each period. Bags were rinsed after removal from the rumen, frozen, and mechanically washed before drying at 55° C. Bags were extracted in neutral detergent to determine aNDF residues. Blank bags were used to correct for DM and aNDF that infiltrated bags during ruminal fermentation. Kinetics were determined using both logarithmic transformation and nonlinear least squares regression. Ruminal pH 3 h post-feeding varied among cows and diets (5.37, 5.53, 5.52, and 5.78 for diets CS24, CS32, AS24, and AS32, respectively). *In situ* digestion kinetics of DM and NDF differed among substrates and were affected by both cow and diet. Differences in digestion kinetics were smaller for concentrates compared to forages. Indigestible matter in substrates differed among cows and diets. In general, the level of NDF in the diet influenced digestion kinetics more than forage source. Both intrinsic feed properties and the ruminal environment affect *in situ* digestion kinetics. Quantitative relationships are needed before practical use of digestion kinetics can be achieved.

Key Words: Rumen, Forage Degradation, Digestion Kinetics

1204 Evaluation of phosphatidylcholine as a marker of protozoal mass in the rumen of steers fed wheat silage diets. K.-H. Südekum* and A. Schröder, *University of Kiel, Germany.*

This study examined the effects of stage of winter wheat maturity and time of sampling on estimates of rumen protozoal organic matter (OM), starch, and crude protein (CP), based on phosphatidylcholine (PC) as a protozoal marker. Six ruminally cannulated Angler Rotvieh steers (458 kg) were given ad libitum access to whole-plant wheat silages from the late milk, early dough, and hard dough stages of maturity, respectively, in a replicated 3 × 3 Latin square experiment. Silages contained, on dry matter basis, starch, 12.7, 20.0, and 25.4%, respectively; and Neutral Detergent Fiber, 50.6, 45.6, and 43.4%, respectively. Diets were balanced to contain 13% CP. Rumen protozoa were isolated at 0030, 0930, and 1730. Rumen ingesta were quantitatively evacuated at 0100, 0500, 0900, 1300, 1700, and 2100 to estimate rumen pool sizes. Stage of maturity had no effect ($P > 0.10$) on concentrations of PC, starch, and CP in protozoa. Averaged across maturities, PC, starch, and CP concentrations in protozoa were 2.7, 29.5, and 40.7% of OM. Time of sampling affected PC ($P < 0.05$), starch, and CP ($P < 0.001$) concentrations in protozoa. The protozoa isolated at 1730 contained less starch and more PC and CP than protozoa from the other sampling times. Percentages of protozoal OM, starch, and CP, respectively, of total rumen pool sizes of these fractions were influenced ($P < 0.001$) by stage of maturity, but only percentage of protozoal starch was influenced by time of sampling ($P < 0.001$). Values for percentages of protozoal OM, starch, and CP ranged from 1.0 to 1.5%, 15.3 to 41.3%, and 2.7 to 4.4%, respectively. The highest values were always associated with the late milk stage silage diet and the lowest values were always associated with the late dough stage silage. When these values were used to calculate rumen pool sizes of protozoal OM, starch, and CP, values ranged from 70 to 98 g, 26 to 35 g, and 29 to 48 g, respectively. These data appeared biologically reasonable and it was concluded that PC can be used as a protozoal marker in steers fed wheat silage-based diets.

Key Words: Marker, Protozoa, Rumen

1205 Effects of defaunation on nitrogen metabolism in the rumen of sheep. K. M. Koenig*¹, L. M. Rode¹, F. M. McIntosh², and C. J. Newbold², ¹*Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada T1J 4B1*, ²*Rowett Research Institute, Bucksburn, Aberdeen, UK.*

Four ruminally cannulated sheep (55 kg average body weight, SD 4.5) received a diet of 600 g alfalfa haylage and 900 g barley concentrate (as-fed basis) per day divided into 12 equal portions and allocated at 2-h intervals. Ruminal nitrogen kinetics were determined following the introduction of a pulse dose of [¹⁵N]ammonium chloride into the rumen and, 7 days later, the introduction of [¹⁵N]urea into the blood and the measurement of ¹⁵N enrichment in ruminal ammonia and plasma urea pools. Total collection of urine was made for five days and analysed for purine derivatives to calculate microbial protein flow. Sheep were defaunated, using a rumen washing procedure, 50 days prior to making measurements in the defaunated period. Numbers of total culturable ruminal bacteria increased following defaunation (6.4 vs. 11×10^8 /ml, SEM 0.90, $P < 0.05$). This was associated with a reduction in ruminal ammonia concentration (279 vs. 153 mg ammonia-N/L, SEM 19.9, $P = 0.02$) and an increase in the flow of microbial protein from the rumen (11.3 vs. 16.9 g N/d, SEM 1.15, $P = 0.042$). As expected, the ruminal ammonia pool was lower in defaunated sheep (1.0 vs. 1.2 g N, SEM 0.28, $P = 0.649$), however, the total flux of N through the pool was similar in defaunated and faunated animals (55.6 vs. 47.4 g N/d, SEM 8.22, $P = 0.532$). Thus, while the irreversible loss of N from the pool increased (15.9 vs. 24.3 g N/d, SEM 3.2, $P = 0.163$), consistent with the increased microbial protein flow from the rumen in defaunated animals, intraruminal recycling of N [corrected for urea N recycled via the blood (4.5 vs. 6.8 g N/d, SEM 1.4)] was similar in defaunated and faunated animals (26.8 vs. 24.7 g N/d, SEM 5.75, $P = 0.808$). In conclusion, although defaunation increased the flow of microbial protein from the rumen by 50% it had only a small effect on reducing the recycling of N within the rumen (53.3 vs. 44.3%, SEM 5.4, $P = 0.324$).

Key Words: Nitrogen, Intraruminal Recycling, Protozoa

1206 Further development of the inhibitor in vitro method. G. A. Broderick*¹, M. L. Murphy², and P. Uden², ¹*U.S. Dairy Forage Research Center, Madison, WI* and ²*Swedish Agricultural University, Uppsala.*

The inhibitor in vitro method was used to estimate rates of ruminal protein degradation for casein, solvent soybean meal (SSBM) and expeller soybean meal (ESBM) from accumulation of ammonia and total amino acids in the presence of hydrazine and chloramphenicol (CAP) in the medium. Protein was added to the medium at 0.13 mg N/ml; incubations were conducted for four or six hours. Inocula were obtained from ruminally cannulated donor cows fed grass silage and hay plus concentrate mixes of barley, oats, sugarbeet pulp, rapeseed meal and soybean meal. Pre-incubation of inocula was used to suppress background ammonia and amino acids. Compared to 0.12 M sodium bicarbonate, adding 0.12 M of an equimolar mixture of mono- and di-sodium phosphate as pre-incubation buffer reduced rates for casein and SSBM. Casein rate was faster ($P < 0.05$) using inocula from two lactating cows (0.27/h) than from two non-lactating cows (0.12/h) that had lower DM intakes; however, SSBM and ESBM rates were not different ($P > 0.10$). Generally, slower degradation rates were obtained for SSBM and ESBM under Swedish conditions than were found previously for the same samples in the U.S. using inocula from donor cows fed diets with similar CP and energy. Compared to 1 mM hydrazine plus 30 mg CAP/L, adding 2 mM hydrazine plus 90 mg CAP/L to the medium increased ($P < 0.05$) recoveries of ammonia and total amino acids (added as acid-hydrolyzed casein) and degradation rates for casein and SSBM. Increasing hydrazine to 4 mM and CAP to 120 mg/L actually suppressed ($P < 0.05$) rates observed for casein alone (92% CP) and casein that had been diluted with starch to 11% CP. There were differences in protein degradation rate due to donor animal ($P = 0.003$) and time after feeding ($P = 0.034$). Analysis of data from multiple time-point incubations indicated that casein degradation followed simple, first-order kinetics; however, degradation of protein in SSBM and ESBM was complex.

Key Words: Protein Degradation, Rumen, Inhibitor In Vitro

1207 The partitioning kinetics of in vitro rumen fermentation products in a gas production test. M. Bluemmel, H. P. S. Makkar, and K. Becker, *Institute for Animal Production in the Tropics and Subtropics (480) University of Hohenheim, Stuttgart, Germany.*

In vitro gas tests are attractive for ruminant nutritionists but there is growing concern that nutritionally wasteful and environmentally hazardous products are being measured. It is therefore important to understand the relationship between useful fermentation products and gases. For this, substrate degradation and kinetics of in vitro partitioning of three German hays, with similar in vivo digestibilities, into short chain fatty acids (SCFA), microbial biomass, ammonia, carbon dioxide and methane was examined at 8, 12, 18 and 24 h of incubation in a gas test under both low and adequate nitrogen (N) levels. Microbial synthesis was quantified gravimetrically, by N balance and purine analysis. SCFA and gas production were positively correlated ($P < 0.0001$) and cumulative at all times of incubation under both low and adequate N levels. On the other hand, microbial biomass, microbial N and microbial purine yield declined after 12 h of incubation while ammonia production increased. Gas or SCFA production were always inversely ($P < 0.05$) related to microbial biomass yield regardless of incubation time and medium (low or adequate N) when related to a unit of substrate degraded. At later incubation times, continuously more SCFA or gas and continuously less microbial biomass were produced reflecting microbial lysis and probably increasing microbial energy spilling. All three hays differed ($P < 0.05$) consistently in how the degraded substrate was partitioned into SCFA and gas and into microbial biomass in both low and adequate N medium. Purine analysis indicated substantial differences in microbial composition across treatments, which might be one explanation for these different microbial efficiencies. In vitro gas measurements only will select for hays with proportionally high SCFA production but low microbial efficiency. Current nutritional concepts aim at high microbial efficiency which can not be achieved by measurement of gas only.

Key Words: In vitro gas test, Microbial yield, Nutrient partitioning

1208 Effect of soybean meal or urea with or without monensin on peptide accumulation in the rumen of steers fed high grain diets. M. A. Cerrillo* and A. Trenkle, *Iowa State University, Ames.*

A 4x4 Latin square designed experiment was conducted with ruminally and duodenally cannulated steers to determine the effects of supplementing ruminant diets with protein or urea and feeding monensin on accumulation of peptide-N in rumen fluid. The study involved four steers (280 kg) fed a cracked corn diet (10% ground cobs) supplemented with either 2.1% urea or 10% soybean meal (SBM) and with or without monensin (30.8 ug/kg). Rumen samples were collected hourly from 0 to 10 h after feeding. Trinitrobenzene sulfonic acid was used for analysis of amino acids before and after hydrolysis of peptides. Amino acids in hydrolyzed samples were purified with a cation exchange column. Ruminant concentrations of free amino acids did not differ among diets. Steers fed SBM had greater ($P < .01$) level of ruminant peptides than those fed urea supplemented diets. Monensin addition to the diets increased ($P < .05$) peptide concentrations with a greater increase occurring with the urea supplemented diet. The results of this study indicate that feeding protein will increase ruminal peptides in cattle fed corn-based diets.

Key Words: Steer, Monensin, Peptides

1209 The adaptation of *Prevotella bryantii* (*ruminicola*) B₁₄ to monensin. T. R. Callaway*¹ and J. B. Russell^{1,2}, ¹*Section of Microbiology, Cornell University, and* ²*Agricultural Research Service, USDA, Ithaca, NY.*

Many gram-negative ruminal bacteria can become monensin resistant, but an adaptation is often required. *Prevotella bryantii* (*ruminicola*) B₁₄ is a gram-negative, starch-utilizing ruminal bacterium that can be highly monensin-resistant. When unadapted cultures were exposed to 10 μ M monensin, the growth rate was 2-fold lower than untreated controls (.24 versus .45 h⁻¹). After only one transfer (10% v/v), the monensin-treated cultures grew as rapidly as controls (.44 versus .45 h⁻¹). Monensin-adapted batch cultures seemed to grow as efficiently as controls, but the ratio of cellular polysaccharide to protein was 55% higher (70 versus 45 μ g polysaccharide/mg protein). After glucose was depleted (stationary phase), the monensin-adapted cells had a higher endogenous metabolic rate and a more rapid decline in intracellular ATP and potassium than controls. Non-growing, glucose-energized cells maintained a potassium gradient across the cell membrane, but monensin addition decreased intracellular potassium. The amount of monensin needed to catalyze half-maximal potassium depletion (K_d) from adapted cultures was 15-fold greater than the K_d of unadapted cultures (213 versus 3245 nM). Based on these results, *P. bryantii* B₁₄ cultures can adapt to monensin and reduce monensin-dependent potassium depletion, but even adapted cells cannot completely exclude monensin from the cell membrane.

Key Words: Monensin, Resistance, *Prevotella bryantii*

1210 Effects of extrusion and ionophore addition on ruminal fermentation in ewes fed diets containing soybean oil. L. A. Burgwald-Balstad*, B. W. Hess, M. B. Whitney, C. M. Tsopito, D. C. Rule, and J. E. Kaltenbach, *University of Wyoming, Laramie.*

Eight multi-cannulated mature ewes (68.4 kg) were used to determine if ionophore addition and/or extruding diets high in unsaturated fatty acids influences ruminal fermentation. Dietary treatments were 0% added soybean oil (C), 6% soybean oil added before extrusion (SB), and 6% soybean oil added after extrusion (SA). Lasalocid (L) or no lasalocid (NL) was included within each dietary treatment. Ewes were fed and dosed with chromic oxide twice daily. Each of the six, 12 d periods contained 10 d for adaptation and 2 d for collections. Duodenal samples were taken to represent every 2 h of a 24-h clock and composited. Ruminant samples were taken every 3 h over a 24-h period. Data were analyzed as a 6 x 6 Latin square with a factorial arrangement of treatments and two extra replications. Mean OM intake across all diets was 1077.8 \pm .16 g. Organic matter flow to the duodenum tended ($P = .09$) to be greater for SA, which resulted in a decrease ($P = .06$) in apparent OM digestibility in the rumen. Ionophore treatment did not affect ($P > .76$) OM flow or apparent digestibility of OM in the rumen. Diet x ionophore interactions were noted for ruminal pH, ammonia concentrations, VFA, and acetate:propionate ratios. Ruminant ammonia concentrations were greater ($P < .05$) for diets with L, except for the SA treatment. Ruminant pH was greater ($P = .02$) for sheep receiving oil diets with L than for sheep receiving the C diet. Addition of lasalocid increased ($P < .001$) ruminal acetate:propionate ratio in the C and SB diets, but not in the SA diet. Both C and SB diets had numerical increases ($P > .10$) in VFA with the addition of L, but the trend reversed for the SA diet. Including soybean oil after a diet has been extruded affects ruminal fermentation of OM as well as fermentation characteristics.

Key Words: Sheep, Soybean oil, Ionophores

1211 Effect of bambermycins on the performance and methane emission of steers grazing winter annual pastures.

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The objective was to determine the effect of supplementation with bambermycins on the performance and methane emissions of steers grazing wheat-ryegrass pastures. Bambermycins were provided in a commercial mineral free-choice while the control received the same mineral without bambermycins. Six 1.0ha pastures were randomly assigned as a control or treatment pasture. Pastures were planted in late August and grazing began in November. Three Hereford steers (250kg) were stocked on each paddock. The grazing period was 202d with forage availability and quality monitored on a 28d basis. Mineral consumption was monitored on a weekly basis and was not different ($P > .20$) between treatments. Mineral intake averaged 142g/hd/d across treatment, which provided the recommended level of 20 mg/hd/d of bambermycins. Twenty-four hr methane emissions were measured for 5d at four different sampling periods. Methane production (g/d) was not affected ($P > .20$) by bambermycins supplementation. Average methane production across treatment and periods was 185g/d. Steer ADG increased 10% with the addition of bambermycins (1.22 vs 1.35 kg/d, $P < .05$). Methane production per unit of gain was decreased (151 vs 139 g/kg, $P < .05$) by bambermycins.

Key Words: Bambermycins, Methane, Steers

1212 The effects of nutrient withdrawal on anaerobic and *E. coli* O157:H7 CFUs.

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We investigated the effects of nutrient withdrawal on the ecology of *Escherichia coli* O157:H7 and total anaerobic rumen microflora in cattle. Rumen fluid was obtained from a cannulated dairy cow maintained on a silage diet supplemented with range cubes (20% protein). The fluid was filtered through three layers of cheese cloth and immediately transferred into two different fermenters. The microflora were maintained via continuous flow (CF) culture under anaerobic conditions using O₂ free CO₂ and operated at a dilution rate of .04 h⁻¹ (corresponding to a vessel turnover time of 24 hours). One of the fermenters was challenged with *E. coli* O157:H7 to a concentration of 10⁷ cfu/ml culture fluid; the second fermenter was not challenged. The microflora of the CF cultures were subjected to nutrient withdrawal by continuous addition of water for the first 48 hours. Subsequently, Viande Levure (VL) medium was supplied in lieu of water as a nutrient source. Total anaerobic and *E. coli* O157:H7 cfu were determined throughout the 48 hour nutrient withdrawal period and for 10 days post nutrient addition. In summary, total anaerobic cfu decreased from 1.5 x 10¹¹/ml to 1.4 x 10⁸/ml at 48 hours (a 3000 fold decrease) while *E. coli* O157:H7 cfu decreased from 2.7 x 10⁷ CFU/ml to 6.0 x 10⁶ cfu/ml (less than a 5 fold decrease). Ratios of total anaerobic cfu to *E. coli* O157:H7 at 0, 24 and 48 h were 5600, 34 and 233, respectively, thus showing that the anaerobes decreased more sharply in number than did *E. coli* O157:H7 during nutrient withdrawal. Upon nutrient addition, total anaerobic cfu increased to near initial levels whereas *E. coli* O157:H7 decreased to undetectable levels 10 d post nutrient addition.

Key Words: *Escherichia coli* O157:H7, Rumen, Continuous-flow

1213 On the determination of ruminal net absorption of ammonia, urea and volatile fatty acids in dairy cow: should we analyze on blood or plasma samples?

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As part of a project aiming to measure net flux of metabolites across the rumen wall, this study was conducted to compare ammonia, urea and volatile fatty acids (VFA) concentrations in whole blood and plasma samples. For this purpose, whole blood samples (n=20) were obtained from the right ruminal vein of a cow fed a diet based on 75% of silage (corn and grass). Packed cell volume (PCV) was determined on fresh blood samples. Aliquots of blood and plasma recovered from blood centrifugation were analyzed immediately for their urea and ammonia concentrations. VFA concentrations were determined on frozen samples of blood and plasma. Metabolite concentrations in blood and plasma samples were statistically compared using Wilcoxon's signed rank test. Results showed that ammonia concentration was greater ($P = .0001$) in blood than in plasma. Inversely, urea concentration was higher ($P = .0001$) in plasma than in blood samples. Individual VFA concentrations were higher ($P < .05$) in plasma than in blood samples. However, when blood and plasma samples were compared on the same volume basis [plasma concentration of metabolites x (1 - PCV/100)], urea, ammonia, acetate, propionate, and iso-butyrate concentrations were lower ($P < .05$) in plasma than in blood whereas butyrate, iso-valerate and valerate concentrations were not significantly different ($P = .0656$, .3446 and .1288, respectively) between plasma and blood samples. This work shows that ammonia, urea, acetate, propionate and iso-butyrate concentrations are different in blood and plasma due to possible contribution of erythrocytes to the transport of these metabolites. It suggests that if exchange between plasma and erythrocytes is rapid, the net transfer across the ruminal wall will be underestimated by analysis of these metabolites in plasma.

Key Words: Blood, Plasma, Metabolites

1214 Effects of Abomasal Fat Infusion on Splanchnic Metabolism and Feeding Behaviour in Lactating Dairy Cows.

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Effects of abomasal fat infusion on DMI, milk production, feeding behaviour and splanchnic (portal-drained viscera [PDV] and liver [LIV]) metabolism were investigated in 6 multigravid, rumen fistulated Holstein x Friesian cows (673 kg BW) at 55 (early) and 111 (mid) d postpartum. Cows were fed a TMR ad libitum in 3 meals per day. Blood sample sets (25) for measurement of plasma flow (L/h) and splanchnic nutrient flux (mmol/h) were taken during 8 h on the last day of a 7 d infusion of water or fat (vegetable oil). Fat infusion decreased DMI (22.8 vs 21.5 kg/d, $P < .02$) but estimated ME (272 MJ/d), milk yield (37.5 kg/d) and milk protein content (31.5 g/kg) were not affected ($P > .20$). Fat infusion increased ($P < .01$) liver NEFA uptake (42 vs 55), PDV (1583 vs 1755) and LIV (2023 vs 2176) plasma flows and LIV lactate uptake (111 vs 160, $P < .05$) but had no effect ($P > .50$) on β -OH-butyrate production by the PDV (263 vs 266) or LIV (372 vs 349) or on total splanchnic insulin release (112 vs 107 μ g/h). Greater milk yield (39.9 vs 35.1 kg/d, $P < .01$) in early lactation was accompanied by greater ($P < .01$) PDV (1731 vs 1607) and LIV (2195 vs 2004) plasma flows, LIV lactate uptake (205 vs 65), PDV NEFA release (25 vs 14) and lower total splanchnic insulin release (98 vs 121 μ g/h, $P < .02$) but DMI was not affected (22.2 vs 22.0 kg/d, $P > .57$). During blood sampling DMI (8.0 kg) was unaffected ($P > .70$) by fat infusion or lactation stage, and fat infusion had no effect ($P > .57$) on time (min) spent eating (111 vs 115) or ruminating (146 vs 141). Cows spent longer eating (123 vs 103, $P < .02$) during sampling in early lactation, thus their rate of eating was slower (68 vs 80 g/min, $P < .08$). The results suggest a role for abomasally infused fatty acids in the regulation of DMI, splanchnic metabolism and diurnal meal patterns.

Key Words: Fatty Acids, Lactation, Splanchnic

1215 Effects of dietary fat and methionine on depletion of liver triglyceride. S. J. Bertics and R. R. Grummer*, *University of Wisconsin, Madison.*

Dietary fat or methionine may influence liver hepatic fatty acid metabolism and liver triglyceride (TG); however, data are limited and inconclusive. The objective of this study was to determine if feeding fat or methionine influences the rate of TG depletion from the liver of cows in positive energy balance after fatty liver was induced by feed restriction. Twenty eight nonlactating Holsteins at least 50 days from calving were used in a randomized block design; 454 g calcium salts of long chain fatty acids/d and 13 g liquid methionine-hydroxy analogue (MHA)/d were applied in a 2 x 2 factorial. To induce fatty liver, cows were restricted to 2.3 kg alfalfa hay for 10 d. At the end of the 10 d feed restriction, blood and liver was sampled and measurements served as covariables. For the next six days, cows were offered ad libitum corn silage, 2.0 kg alfalfa hay, and 1.3 kg of test concentrate that contained the treatments. Blood and liver measurements were repeated on d 13 and 16 (3 and 6 d following feed restriction). There were no fat x methionine interactions. Mean liver TG after 10d of feed restriction was 29.0% (DM basis).

	-fat	+fat	-MHA	+MHA
Day 13 liver TG, ¹ %	18.7	24.3	23.0	20.0
Day 16 liver TG, ¹ %	13.8	20.0	16.8	17.1
Day 13+16 NEFA, ueq/L	272	345	270	346
Day 13+16 glucose, ² mg/dl	62.9	57.7	61.2	59.4
Corn silage DMI, kg/d	6.0	5.9	6.3	5.6

¹Significant effect due to fat (P < 0.05).

²Significant effect due to fat (P < 0.01).

Feeding supplemental fat reduced TG depletion from the liver when cows were in positive energy balance following feed restriction. Feeding 13 g/d liquid MHA did not affect TG depletion from the liver.

Key Words: Fatty Liver, Fat, Methionine

1216 Serum insulin, prolactin, and aldosterone in ewes infused ruminally with glucose. M. S. Brown¹, J. A. Hernandez^{1*}, D. M. Hallford¹, J. B. Richards¹, H. J. Al-Tamimi¹, M. L. Galyean², C. R. Krehbiel¹, and G. C. Duff¹, ¹New Mexico State University, Las Cruces; ²Texas Tech University, Lubbock.

Twelve, 18-mo-old Debouillet ewes were limit-fed a 90% concentrate diet for 30 d and then assigned randomly to receive 0, 5, or 10 g of glucose/kg of BW by esophageal intubation. Jugular blood (venipuncture) was collected before and at 30-min intervals for 12 h after glucose infusion. Serum glucose was quantified at 0, 3, 6, 9, and 12 h after dosing and insulin, prolactin, and aldosterone were measured in all samples. Glucose infusion by sampling time interactions were detected (P<.01) for all hormones; therefore, treatment effects were examined within sampling time. Serum glucose was similar (P>.50) among groups before glucose was infused; but by 3 h after dosing, serum glucose was 79, 100, and 194 (±22) mg/dL in ewes receiving 0, 5, and 10 g of glucose/kg of BW. Serum insulin in the three respective groups was 1.2, 3.2, and 9.7 (±1.4) ng/mL at 3 h (linear, P<.01). Serum insulin peaked at 5 h after dosing (1.2, 3.0, and 16.0±.5 ng/mL, respectively; quadratic, P<.01). Area under the serum insulin curve (AUC) over the 12-h period was 14, 24, and 101 (±6) units in ewes treated with 0, 5, and 10 g glucose/kg BW, respectively (quadratic, P<.01). No major effect (P>.10) of glucose infusion was observed for serum prolactin. Serum aldosterone was similar (P>.10) among groups for the first 5 h after dosing. At 5.5 h after glucose infusion, serum aldosterone was 39, 26, and 92 (±17) pg/mL in ewes treated with 0, 5, and 10 g glucose/kg BW, respectively (quadratic, P=.09). At 12 h after dosing, serum aldosterone was 133, 101, and 319 (±45) pg/mL in the three respective groups (quadratic, P=.05) and aldosterone AUC was 885, 504, and 1,440 (±237) units, respectively (quadratic, P=.05). Serum insulin and aldosterone may prove beneficial as markers of metabolic disturbances occurring when ruminants are exposed to diets that increase organic acid load.

Key Words: Sheep, Acidosis

1217 Effect of storage on ammonia and urea concentrations in blood and plasma samples prepared for measurement of net flux across ruminal wall in dairy cow. A. Desrochers^{*1}, C. Benchaar², and C. L. Girard², ¹Faculté de médecine vétérinaire, Université de Montréal, St-Hyacinthe, Canada ²Agriculture and Agri-Food Canada, Dairy and Swine R&D Centre, Lennoxville.

The objective of this study was to evaluate the effect of storage on urea and ammonia concentrations in whole blood and plasma samples used for calculation of net flux rates across the ruminal wall of dairy cows. Blood samples (n=20) were obtained from the right ruminal vein of a cow fed a diet based on 75% of silage (grass and corn). Aliquots of blood and plasma recovered from blood centrifugation were analyzed for their urea and ammonia concentrations immediately after sampling, after storage overnight at + 4°C and after freezing at -20°C for 3 weeks. Blood was hemolysed before storage. Wilcoxon's signed rank test was used to compare urea and ammonia concentrations in fresh and stored samples. Results showed that storage of samples overnight at + 4°C increased blood ammonia concentration (+ 6%; P=.0005) but decreased plasma ammonia concentration (- 11%, P=.0001). Freezing increased ammonia concentrations in both blood and plasma samples (+ 38% and + 15%, respectively; P=.0001). Storage at + 4°C overnight increased urea concentrations in blood and plasma samples (+ 4% and + 3%, respectively; P=.0001). However, freezing did not influence blood and plasma urea concentrations (P=.8717 and .2417, respectively). This work indicates that storage of blood and plasma samples alters their urea and ammonia concentrations. This emphasizes the advantage of analyzing these nitrogen compounds on fresh samples. Therefore, caution must be taken in comparison of literature results if sample storage was different from one experiment to another.

Key Words: Blood, Plasma, Storage

1218 Response of hepatic glutaminase and glutamine synthetase to level of dietary protein in lambs. J. H. Eise-mann*, *North Carolina State University, Raleigh.*

The objective was to measure kinetics of ruminant liver glutaminase and determine whether the enzyme responded to level of dietary protein. Twelve crossbred lambs (BW=31±2.6 kg) were stratified by weight and grouped into six pairs from highest to lowest weight. One lamb of each pair was fed a 10% crude protein (CP) diet and the other was fed a 15% CP diet. The 10% CP diet was 77.7% corn and 4.3% soybean meal. The 15% CP diet was 66.0% corn, 12.7% soybean meal and 3.0% fishmeal. Both diets contained 15% cottonseed hulls, 1.0% corn oil, plus vitamins and minerals. Feed was offered at .218 Mcal ME/kg BW^{.75} daily in two equal feedings. Treatment period was 20 days. Nine blood samples were taken over a 5-hour period from jugular catheters on d18. On d20, lambs were killed and livers removed for assay of glutaminase and glutamine synthetase activities, and DNA, RNA and protein concentration. Concentrations of glutamine and glutamate in blood, and ammonia in plasma did not differ between treatments. Means (SE) for lambs on the 10% CP and 15% CP diets, respectively, were: glutamine 277 vs 284 μM (12 μM); glutamate 70.6 vs 71.4 μM (4.7 μM); ammonia 30.8 vs 36.0 μM (2.4 μM). Plasma urea was higher (P<.01) for lambs on the 15% CP diet (2.8 vs 6.3 mM, SE=.3 mM). Activity of glutamine synthetase and glutaminase did not differ between treatments. Means (SE) for lambs on the 10% CP and 15% CP diets, respectively, were: glutamine synthetase 592 vs 605 mU/mg protein (SE=81); glutaminase predicted V_{max} 1.19 vs 1.40 μmoles glutamate produced/min per mg protein (SE=.17) and K_m 7.80 vs 8.18 mM glutamine (SE=.15). Weight of liver was higher in lambs on the 15% CP diet (646 vs 507 g, SE=24). Concentration of DNA in liver was lower (P<.01) on the 15% CP diet but total liver DNA did not differ between the two diets. Total RNA and protein in liver were higher (P<.05) on the 15% CP diet. Despite a marked difference in protein status there were no changes in specific activity of liver enzymes involved in metabolism of glutamate and glutamine.

Key Words: Lambs, N Metabolism, Hepatic

1219 Effects of infusions of non selective beta-, and selective beta1-, or beta2-adrenergic agonists on plasma non-esterified fatty acids in underfed or overfed nonpregnant heifers. A. Ferlay and Y. Chilliard*, *INRA, Theix, France.*

Stimulation of β -adrenoceptors (β -AR) by catecholamines or β -agonists (β -A) increases adipose tissue (AT) lipolysis and the release of non-esterified fatty acids (NEFA). Literature data suggest that β 2-AR are present in excess over β 1-AR in calf adipocytes. However, there is no published data in ruminants on the respective responses of plasma NEFA levels to selective β 1 or β 2-A during underfeeding (U) and overfeeding (O). Four nonpregnant heifers were used in a crossover design with two treatments for each animal (U or O, 58 or 135% of maintenance energy requirements). Isoproterenol (ISO, a non selective β -A, 0.07 nmol/kg BW/min), terbutaline (TER, a selective β 2-A, 0.07 nmol/kg BW/min), and dobutamine (DOB, a selective β 1-A, 1.5 nmol/kg BW/min) were infused into a jugular vein during 60 min. Blood samples were obtained from the contralateral vein at -5, 10, 20, 30, 45 and 60 min after the start of the infusion. NEFA maximal response (Rmax) to ISO was 1152 and 1859 μ M ($P < 0.01$) for diets O and U, respectively. TER had only a lipolytic effect during U (Rmax was 407 μ M) and plasma NEFA level was not significantly changed by DOB (Rmax was 120 μ M). The Rmax to TER represented only 22% of the Rmax to ISO. AT lipolysis in cattle do not seem to be coupled with β 1-AR, contrarily to humans and rats. Differences between the 3 β -A could also be explained by differences between ISO, TER or DOB in affinities for each subclass of β -AR, or in their respective clearance rates. The lipolytic effect of ISO or TER could also be amplified by their effect on endogenous catecholamines via prejunctional β 2-AR of the sympathetic nerve terminals. ISO could also stimulate other β -AR (i.e. β 3, although our preliminary results using *in situ* microdialysis do not show any lipolytic response of AT to a β 3-A in underfed ewes). In cattle, U increased the *in vivo* lipolytic response to β - and β 2-A, without changes in β 1-A response, in contrast with *in situ* data in humans.

Key Words: Cattle Underfeeding, Adipose Tissue, Beta-adrenergic Lipolysis

1220 Feeding value of dried ruminal contents in growing-finishing diets for Feedlot Cattle: Metabolism. A. Plascencia¹, G. E. Arellano¹, L. J. Galván*¹, M. A. López-Soto¹, J. Meléndrez¹, J. Rodríguez, and R. A. Zinn^{1,2}, ¹*Instituto de Ciencias Veterinarias-UABC, Mexicali (México),* ²*University of California, El Centro.*

Eight Holstein steers (458 kg) with cannulas in rumen and proximal duodenum were used in a crossover design experiment to determine the feeding value of air-dried ruminal contents (RC). Treatments consisted of a steam-flaked corn-based growing diet containing 30% of either alfalfa hay ALF or RC. The ALF contained 93.4% DM, 13.3% CP, 36.7% ADF, 1.0% EE, and 7.3% ash. The RC contained 92.8% DM, 9.2% CP, 44.3% ADF, 3.8% EE, and 5.9% ash. Ruminal contents were obtained at a local cattle slaughtering facility. The material was first conveyed over a screen to separate liquids and solids. Solids were then spread over a concrete surface and allowed to air-dry. Dry matter intake was restricted to 9.6 kg/head/d. Substituting RC for ALF in the diet decreased ruminal digestion of OM 18%, $P < .01$ and ADF (46%, $P < .01$), post-ruminal digestion of starch (4.7%, $P < .05$) and OM (17.7%, $P < .01$), total tract digestion of OM (15.4%, $P < .01$) and N (12.0%, $P < .01$), and DE (11.8%, $P < .01$). Substituting RC for ALF in the diet increased ($P < .01$) ruminal microbial efficiency (31%), ruminal N efficiency (24%). The DE value of RC was 1.10 Mcal/kg, approximately 45% of a medium quality alfalfa hay.

Key Words: Ruminal Contents, Metabolism, Cattle

1221 Effects of abomasal maize starch infusion on splanchnic metabolism and milk production in dairy cows.

C. K. Reynolds*, D. J. Humphries, J. A. Benson, J. D. Sutton, and D. E. Beever, *CEDAR, Department of Agriculture, The University of Reading, Earley Gate, UK.*

The responses of splanchnic nutrient absorption and metabolism to post-ruminal maize starch supplementation were measured in 5 multiparous, ruminally cannulated, multicatheterized Holstein \times Friesian cows. Cows averaged 731 kg BW, 317 d postpartum and 219 d of gestation and were fed dehydrated lucerne, grass silage and pelleted concentrates at 30, 20 and 50%, respectively, of DM offered (17% CP). Daily rations were fed hourly as 24 equal meals and were restricted to 95% of ad libitum intake. Hourly measurements (6) of net nutrient metabolism (mmol/h) by portal-drained viscera (PDV) and liver (LIV) were obtained during the last day of 6 d abomasal infusions of water (9 L/d) and 8 d abomasal infusions of maize starch (1200 g in 9 L water/d). Intakes were numerically lower during starch infusion (19.0 vs 18.7 kg DM/d; $P < .13$). Starch infusion decreased milk yield (19.5 vs 18.4 kg/d; $P < .04$) and increased milk protein content (3.7 vs 3.8%; $P < .04$), but did not affect milk protein yield (714 g/d; $P > .13$). Starch infusion increased blood plasma flow in both PDV (1210 vs 1247 L/h; $P < .03$) and LIV (1387 vs 1466 L/h; $P < .08$), increased net PDV absorption of glucose (19 vs 69; $P < .03$) and decreased net PDV absorption (645 vs 453; $P < .01$) and LIV removal (634 vs 453; $P < .05$) of ammonia. Starch infusion did not alter ($P > .20$) net flux of lactate and oxygen for PDV (150 and -3394, respectively) and LIV (-76 and -2820, respectively). Increased post-ruminal starch fermentation could explain the decrease in ammonia absorption observed and account for part of the infused starch not absorbed as glucose. The recovery of abomasally infused maize starch as increased net PDV glucose absorption was only 25%, but increased PDV glucose utilization may in part counter increased glucose absorption.

Key Words: Post-ruminal, Starch, Splanchnic

1222 Effect of post-ruminal protein infusion on pancreatic exocrine secretion in beef steers. C. J. Richards^{1*}, K. C. Swanson¹, D. W. Bohnert¹, S. J. Lewis¹, D. L. Harmon¹, and G. B. Huntington², ¹*University of Kentucky, Lexington,* ²*North Carolina State University, Raleigh.*

The objective of the experiment was to evaluate the effect of post-ruminal protein infusion on pancreatic exocrine secretion. Eight steers (295 \pm 23 kg) with pancreatic pouch-duodenal re-entrant cannulas and abomasal infusion catheters were used in a replicated 4 \times 4 Latin square.

All steers were abomasally infused with 1050 g/d of starch and 0, 60, 120, or 180 g/d casein suspended in water to yield 6000 g/d of infusate. Steers were limit fed (1.5 \times NE_m; 12 equal portions/d) a corn silage based diet (90% DM basis) formulated to contain 12.5% CP. Periods consisted of 3 d of infusion adaptation, 7 d of full infusion, 1 d of collection, and 7 d of rest. Pancreatic fluid was continuously collected over 6 h in 30 min intervals. Sample weight and pH of 30 min samples were recorded, a 10% subsample composited, and remaining fluid returned to the duodenum. Samples were stored (-20° C) until analysis for total protein and activities of α -amylase, trypsin and chymotrypsin. Sample weight and pH of pancreatic secretions were not affected ($P > .10$) by infusion of casein. The secretion rate (1536 g/h) and concentration (10.2 mg/mL) of protein in pancreatic secretions were not affected by infused casein. Casein infusion linearly increased ($P < .03$) α -amylase concentration (182 to 271 units/mL and 17.5 to 24.6 units/mg protein) and secretion rate (26847 to 41894 units/h). Infusion did not change ($P > .10$) trypsin or chymotrypsin concentrations (1379 or 349 units/L and .134 or .033 units/mg protein) or secretion rates (206 or 52 units/h). Abomasal infusion of protein stimulated pancreatic secretion of α -amylase activity into the intestine.

Key Words: Pancreatic Secretion, Amylase, Protein

1223 Influence of abomasal infusion of glucose or starch hydrolysate on pancreatic exocrine secretion in beef steers. K. C. Swanson*, C. J. Richards, and D. L. Harmon, *University of Kentucky, Lexington*.

Five steers (348 ± 12 kg) surgically fitted with pancreatic pouch-duodenal re-entrant, and abomasal infusion cannulas were used in a 5 × 5 Latin square design to examine the influence of form and level of abomasal carbohydrate infusion on pancreatic exocrine secretion. Steers were fed a fescue hay-based diet (96% DM basis) at 1.5 times NE_m , supplemented to meet DIP and metabolizable protein requirements for a steer gaining .83 kg/d (1996 NRC). Abomasal infusion (250 g/h) treatments were water (control), 20 g/h glucose, 40 g/h glucose, 20 g/h partially hydrolyzed starch (SH), and 40 g/h SH. Abomasal infusion periods were 7 d with 3 to 4 d rest between periods. After 7 d of infusion, pancreatic juice was collected under continuous vacuum over 30 min intervals for 6 h. Weight and pH of 30-min samples were measured and a 10% subsample composited and frozen until analysis of total protein and α -amylase, trypsin, and chymotrypsin activities. The remaining sample was returned to the duodenum via the re-entrant cannula. Contrast statements used to compare treatment means were control vs carbohydrate (glucose and SH), glucose vs SH, linear effect of glucose, and linear effect of SH. Abomasal infusion of carbohydrate increased ($P = .04$) total secretion of pancreatic juice from 189 to 215 g/h. Total juice secretion also increased linearly ($P < .03$) from 189 to 226 and 189 to 233 g/h due to abomasal infusion of glucose and SH, respectively. Secretion of α -amylase activity decreased ($P = .01$) from 54402 to 37409 units/h when comparing control vs carbohydrate. Secretion of α -amylase activity decreased linearly ($P < .09$) from 54402 to 37683 and 54402 to 31560 units/h due to abomasal infusion of glucose and SH, respectively. Secretion of trypsin and chymotrypsin activity was not influenced ($P > .10$) by carbohydrate abomasal infusion. These data indicate that abomasal infusion of glucose or SH increases total secretion of pancreatic juice and decreases secretion of α -amylase activity.

Key Words: Steer, Carbohydrate, Pancreatic Secretion

1224 Effect of dietary protein depletion and repletion on plasma IGF-1 and hepatic IGF-1 mRNA. P. J. Tyler¹*, K. A. Cummins¹, and G. M. Davenport², ¹*Auburn University, Auburn, AL*, ²*IAMS Company, Lewisburg, OH*.

Sixteen lactating dairy cows (4/diet) were assigned at random to either 9, 12, 15, or 18% CP diets at 30 DIM after being fed an 18% CP diet beginning at calving. Depletion phase lasted from 30 to 58 DIM, followed by a repletion phase from 59 to 84 DIM where the cows were fed an 18% CP diet. All diets were based on corn silage, cracked corn, and soybean meal. Blood samples were taken at 30, 49, 63, 77, and 84 DIM. Liver biopsies were taken at 63 and 84 DIM, during the repletion phase. Plasma IGF-1 was measured using an RIA. Hepatic IGF-1 mRNA was measured using a Northern blotting technique. DMI and milk production did not vary by diet ($P > .1$). Plasma IGF-1 (ng/ml) increased from 38.0 at 30 DIM to 66.4 at 84 DIM in cows fed the 12% CP depletion diet ($P < .05$), and from 29.5 to 54.1 in cows fed the 15% CP depletion diet ($P < .05$). Plasma IGF-1 did not vary in cows fed either the 9 or 18% CP depletion diets over the course of the study ($P > .1$). At 84 DIM, plasma IGF-1 was 25.3, 66.4, 54.1, and 57.6 ng/ml in cows fed the 9, 12, 15, and 18% CP diets, respectively. IGF-1 was higher in cows fed greater than 9% CP ($P < .05$). Relative intensity of hepatic IGF-1 mRNA for the 9, 12, 15, and 18% diets respectively was 573, 575.1, 583.3, and 780.2 at 63 DIM and 395, 467.1, 670, and 749.7 at 84 DIM. Hepatic IGF-1 mRNA was higher in cows fed the 18% diet at 63 DIM ($P < .05$) and in cows fed the 15 and 18% diets at 84 DIM ($P < .05$). Plasma IGF-1 does not reflect changes in hepatic IGF-1 mRNA. Hepatic mRNA for IGF-1 is affected by dietary protein independent of energy intake and during repletion following depletion of body protein caused by low dietary protein intake.

Key Words: Lactation, Dairy, Nutrition

1225 Ammonium chloride infusion into the mesenteric vein alters dry matter intake and plasma ammonia concentrations in wethers. J. Williams¹*, G. Waghorn², D. Shelton², P. Harris², and G. Reynolds², ¹*University of Missouri, Columbia, MO* and ²*New Zealand Pastoral Agriculture Research Institute, Palmerston North, New Zealand*.

The study was designed to evaluate chronic and acute effects of ammonium chloride (NH_4Cl) infusion into the mesenteric vein on DMI and plasma ammonia concentrations in wethers. Four Romney wethers (avg 42 kg) were assigned to a Latin square design. Each period lasted 7 days and consisting of 3 days of adjustment and 4 days of infusion. Wethers were surgically altered by inserting ruminal cannulae and mesenteric catheters. Wethers were fed processed alfalfa twice daily at 0800 and 2000 h (2.8% BW on DM basis, 23.9 g N/kg DM and 12.3 MJ ME/kg DM). The treatments consisted of infusion rates of NH_4Cl (0, 300, 600 and 900 $\mu M/min$) and infused 30 min post-feeding for 2.5 h. The DMI was measured daily (24 h DMI), as well as 1 h challenge (1.0 h DMI) of 250 g of alfalfa pellets offered 1 h after the evening meal. The blood was collected via jugular catheters at 0, 30, 60, 90, 120, 150, 180, and 210 min post-feeding. The 24 h DMI decreased ($P < 0.05$) linearly and quadratically with increasing NH_4Cl infusion rates (1,147, 1,093, 1,064, 1,112 g). For 1 h DMI, there was a linear decrease ($P < .05$) in DMI (181, 168, 117, 134 g) with NH_4Cl infusion rate. Plasma ammonia ($\mu M/L$) increased ($P < .05$) linearly with NH_4Cl infusion rate. In conclusion, NH_4Cl infusion into the mesenteric vein had chronic and acute effects on DMI.

Key Words: Ammonia, Intake, Mesenteric Vein

1226 Tissue distribution of mRNA for a peptide transporter(s) in sheep, lactating cows, pigs, and chickens. H. Chen, E. A. Wong, and K. E. Webb, Jr., *Virginia Polytechnic Institute and State University, Blacksburg*.

To further study the mRNA found in sheep omasal epithelium encoding for a peptide transport protein(s), a 446-bp cDNA fragment was cloned from sheep omasal epithelium RNA. This fragment had 80.3, 83.5, and 79.3 percent identity with the nucleic acid sequences of rabbit, human, and rat peptide transporter (PEPT1), respectively. The fragment was radiolabeled for use as a probe to study the distribution of the mRNA in various tissues. Total RNA was extracted and mRNA was isolated from the epithelium of gastrointestinal segments and other tissues as indicated. Northern blot analysis was conducted using the radiolabeled probe. In sheep (6) and lactating Holstein cows (3), hybridization was observed with mRNA from the omasum, rumen, duodenum, jejunum, and ileum. The estimated size of mRNA was 2.8 kb. No hybridization was observed with mRNA from the abomasum, cecum, colon, liver, kidney, and semitendinosus and longissimus muscles of either species or the mammary tissue from the cows. In pigs (6), the probe hybridized with mRNA from the duodenum, jejunum, and ileum. There was no hybridization with mRNA from the stomach, large intestine, liver, kidney, and semitendinosus and longissimus muscles. Two bands, 3.5 and 2.9 kb were observed with northern blot analysis, indicating two RNA transcripts that may result from alternative mRNA splicing. In both leghorns (15) and broilers (20), the strongest hybridization was found in the duodenum while the jejunum and ileum showed faint bands. The size of mRNA in chickens was 1.9 kb. Other tissues, including the crop, proventriculus, gizzard, ceca, liver, kidney, and muscles showed no hybridization to the probe. In conclusion, mRNA for a peptide transport protein(s) is present in the small intestine of all animals examined and the omasal and ruminal epithelium of sheep and dairy cows. The size of the mRNA varied among species.

Key Words: Peptide, Transport Protein, Messenger RNA

1227 Using mixed models an easier and safer linear models procedure. L. W. Douglass, *University of Maryland, College Park.*

General Linear Models programs, GLM in SAS[®], are commonly used to compute analyses of variance. These General Linear Models programs were developed to fit fixed sources of variation such as treatments. That is, they were designed to model treatment means. Although random sources of variation, such as animal, are commonly added to the GLM model, in many situations the resulting standard errors and tests of hypotheses are incorrect. General Linear Mixed Models programs, MIXED in SAS[®], were developed to fit both fixed and random sources of variation correctly. Thus, we can model the means for the fixed effects and the variances for the random effects. It is the capability to more correctly model the random variances that makes the MIXED procedure a better linear models tool than GLM. Features added to the MIXED procedure will in many cases increase the power or sensitivity of your data analysis. The capability to partition experimental variance or to estimate and use the covariance matrix (correlation) are two features which have frequent applications in the analysis of data from animal research. A common source of non-independent data is from repeated measures experiments and MIXED provides several variance-covariance structures to fit repeated measures data. Correlated data also occurs due to animal spacing or the location where samples are taken. For example, animals housed close together are likely to have correlated responses or tissue samples taken from different muscles are likely to exhibit some correlation structure. Some other problems that commonly occur in GLM analyses are reduced or eliminated with the use of the MIXED procedure. An example is the non-estimability problems that occur in the analysis of some unbalanced experiments or in some covariance analyses. My objective is to convince you that the MIXED procedure is not difficult to use and is safer since it will help you avoid many of the pitfalls that occur when using GLM.

Key Words: Mixed Linear Models

1228 Analysis of day-to-day variation in the feed intake of lactating dairy cows. M. A. P. Shah^{*1}, M. R. Murphy¹, R. N. Corley III¹, C. Cain¹, V. M. Carson², N. L. Whitehouse², P. S. Erickson², and C. G. Schwab², ¹*University of Illinois, Urbana*, ²*University of New Hampshire, Durham*.

Our objective was to examine day-to-day variation in the feed intake of dairy cows in early lactation. Feed intake data for two groups of Holstein cows, 35 at Illinois and 34 at New Hampshire, were used in this study. Cows were fed total mixed diets for the first 70 d of lactation. Either an exponential model ($R^2 = 0.74$, $n = 30$, and $R^2 = 0.46$, $n = 30$, for Illinois and New Hampshire cows, respectively) or a linear model ($r^2 = 0.49$, $n = 5$, and $r^2 = 0.45$, for Illinois and New Hampshire cows, respectively) was used to describe increases in feed intake after parturition and residuals were computed. For Illinois data, it was shown that environmental factors (air pressure, maximum temperature, and day length) explained 4% of the residual variation ($P < 0.05$); however, it also appeared that there were regular patterns in residuals for many cows. Patterns were examined using the model $R = A \times \cos(\omega t + \phi)$, where R = residual daily dry matter intake, A = amplitude, ω = angular frequency, t = time, and ϕ = phase. This model explained 27% of the residual variation for Illinois cows and 19% for New Hampshire cows. Overall, 78% of the variation in daily feed intake for Illinois cows and 56% for the New Hampshire cows was explained by the two functions. Although much of the day-to-day variation in feed intake was accounted for, factors responsible for the patterns observed require further study.

Key Words: Feed Intake, Early Lactation

1229 Prediction of microbial N flow to the duodenum of cattle based on DMI, NE_L intake or diet composition. B. S. Oldick^{*}, J. L. Firkins, and N. R. St-Pierre, *Ohio State University, Columbus.*

Treatment means (213) from 55 trials were subjected to backward multiple regression to develop equations to predict microbial N (MN) flow (g/d) to the duodenum of cattle. Variation within and among trials was accounted for by weighting the data and including trial effects in all models. This eliminated patterns in residuals and gave high r^2 and low CV values; however, for prediction purposes trial effects are random and unknown. Significance of models and of model coefficients was declared at $P < .05$, but least significant coefficients were removed from the model until all variance inflation factors were < 100 to reduce over parameterization. Models based on only lactating cows did not fit lactating cow data better ($P > .05$) than models based on all animals; only equations based on all animals are presented. The equation to predict MN based on NE_L intake (NE_LI; Mcal/d) { $MN = 6.13(SE = 13.9) + 7.57(SE = .56) \times NE_L I$, (Eqn 1); $r^2 = .98$, $CV = 12.28\%$ } was different from the equation used by the current dairy NRC. DMI (kg/d) predicted MN { $MN = -32.9(SE = 16.5) + 19.7(SE = 2.9) \times DMI - .245(SE = .110) \times DMI^2$, (Eqn 2); $r^2 = .98$, $CV = 10.99\%$ } as well as did NE_LI, indicating that DMI drives predictions based on NE_LI. When multiple dietary factors (i.e., DMI; dietary % of CP, forage, and NDF; and all two-way interactions) were included, the resulting model { $MN = 16.1(SE = 23.4) + 22.9(SE = 3.1) \times DMI - .365(SE = .117) \times DMI^2 - 1.74(SE = .41) \times NDF(\%)$, (Eqn 3); $r^2 = .98$, $CV = 9.25\%$ } fit the data better than Eqn 1 ($P < .05$) but not Eqn 2 ($P > .05$). DMI and multiple-factor models for animals fed fat did not fit better ($P > .05$) than Eqn 2 and Eqn 3, respectively. However, a NE_LI model for animals fed fat { $MN = 123.8(SE = 31.1) + 2.59(SE = 1.22) \times NE_L I$, (Eqn 4); $r^2 = .99$, $CV = 9.61\%$ } tended ($P < .10$) to fit the observations better than Eqn 1. Eqn 3 appears to be the best overall model for prediction. However, an asymptotic multiple-factor model { $MN = 478.5(SE = 89.9) \times (1 - (\exp(-.0573(SE = .0220) \times DMI))) - (1.72(SE = .41) \times NDF(\%))$, (Eqn 5); $r^2 = .98$, $CV = 9.27\%$ } may be more appropriate when extrapolating beyond the data range (i.e., $DMI > 26.8$ kg/d).

Key Words: Ruminant, Microbial Nitrogen, Prediction

1230 Evaluation of Computer Models of Ruminal Fermentation for Accuracy and Precision in Predicting Crude Protein and Amino Acid Flow to the Duodenum. H. G. Bateman^{1*}, J. H. Clark¹, C. J. Peel², R. A. Patton³, and C. G. Schwab⁴, ¹*University of Illinois, Urbana*, ²*Degussa Corp., Ridgefield Park, NJ*, and ³*Nittany Dairy Nutrition, Mifflinburg, PA* ⁴*University of New Hampshire, Durham*.

Individual cow data from six trials representing 148 observations were simulated using the 1989 NRC, Cornell Net Carbohydrate and Protein System (CNCPS), University of Pennsylvania Net Carbohydrate and Protein System (PENN), and Mepron Dairy Ration Evaluator. Predictions of duodenal CP flow (g/d) were compared with measured flows of CP assuming that measurements were observed without bias. Models over predicted flows of bacterial CP and under predicted flows of feed CP to the duodenum. Errors in predicting bacterial CP and feed CP flow when combined helped to alleviate errors in predicting total CP flow to the duodenum. Predicted flows of CP were generally lower than observed flows. Predicted flows of some individual AA (g/d) differed from observed.

Item	Trial	NRC	Mepron	PENN	CNCPS	SEM
Total CP flow	3559 ^a	3142 ^b	3295 ^{ab}	3183 ^b	3409 ^{ab}	103.3
Bact CP flow	1736 ^b	2005 ^{ab}	2216 ^a	2340 ^a	2085 ^{ab}	136.0
Feed CP flow	1823 ^a	1137 ^c	1142 ^c	1004 ^c	1317 ^b	59.7
Met	56 ^b		57 ^b	66 ^a	66 ^a	2.1
Lys	198		189	195	196	5.8
Leu	291 ^a		232 ^b	227 ^b	216 ^b	9.5
Ile	153		145	146	147	4.3
Thr	151 ^a		134 ^b	150 ^a	135 ^b	5.1
Val	188 ^a		156 ^b	163 ^b	159 ^b	4.6
Arg	146 ^b			172 ^a	171 ^a	4.1
His	74			72	71	1.9
Phe	159 ^a			144 ^b	143 ^b	3.1

^{a,b} Means within a row lacking a common superscript differ ($P < 0.05$).

Key Words: Modeling, Amino acid, Protein

1231 A mechanistic mathematical model of amino acid absorption by the small intestine of the dairy cow. J. A. Maas*, J. France, D. E. Beever, L. A. Crompton, and C. K. Reynolds, *Department of Agriculture, The University of Reading, UK.*

A dynamic mechanistic computer model of individual amino acid (AA) absorption by enterocytes of the small intestine of the dairy cow has been developed. 20 individual AAs are represented in each of 3 distinct biological compartments: the small intestinal (SI) lumen; the enterocyte cytosol; and the blood perfusing the SI enterocytes respectively. All transport is represented bidirectionally and occurs via 7 AA transporters (Imino, B, A, ASC, Xag, L, y+) across the brush border membrane between the SI and the enterocyte cytosol, and via 5 AA transporters (A, ASC, Xag, L, y+) across the serosal side membrane between enterocyte cytosol and capillary blood. The transporters exhibit saturable behaviour in vitro, thus are appropriately represented by Michaelis-Menten saturation-type kinetic equations. Some of transporters are Na+-dependent (Imino, B, A, ASC, Xag), the remainder are Na+-independent (L, y+). Flux rates across the membranes are dependent on individual AA concentrations on either side of the membrane, and in the case of the Na+-dependent transporters, the Na+ gradient across the membrane. The model can simulate response to normal diurnal patterns of digesta flow to the duodenum and can accommodate different feeding patterns from once daily to continuous feeding. The model demonstrates how enterocytes can extract AAs from either the brush border or serosal side, but rely on absorption from the serosal side when the rate of digesta flow to the small intestine is reduced. The variation in the profile of AA concentrations across the three adjacent compartments appears to be due to preferential absorption of certain AAs, which is controlled by the profile of AA transporters present, and the concentration of individual AA presented to the enterocytes on either side.

Key Words: Amino-Acid, Intestine, Transport

1232 A comparison of the 1996 Beef NRC model feed library. P. H. Doane*, A. N. Pell, and D. G. Fox, *Cornell University, Ithaca, NY.*

The 1996 Beef NRC model feed library was evaluated for the accuracy of feed chemical analyses, energy and protein degradability values. Diets were formulated with the Beef NRC 1996 Level 2 with intake set at 1X and 3X maintenance levels of DMI. A small amount of each feed (.45 kg) published in the feed library was individually added to these rations. The apparent TDN and UIP values were then computed for the feed. In a separate comparison, the 1992 Weiss equation was used to calculate TDN from the published feed composition. Level 2 at 1X and the Weiss equation provided similar TDN values to those published for Level 1 for most feeds but there were important exceptions. Animal proteins had a higher TDN in Level 2 than in the Beef NRC tables. When the tabular values and the Level 2 predictions were compared, rankings of forages were not always similar. Level 2 generally predicted a lower UIP value at 1X than the tabular values. The situation was reversed at 3X: Level 2 at 3X predicted a higher UIP than the tabular values. The 1996 Beef NRC includes a combination of tabular values and a modeling approach to predict the biological value of feeds from feed analyses. Some of these discrepancies arise because of inconsistencies in feed identification and others are due to feeds, such as animal proteins, that pose analytical problems.

Key Words: Feed Composition, NRC, Model

1233 Rumen fermentation stoichiometry in lactating dairy cows. A. Bannink*¹, J. Dijkstra², J. France³, and S. Tamminga², ¹*DLO-Institute for Animal Science and Health, Lelystad*, ²*Wageningen Agricultural University, The Netherlands*, and ³*University of Reading, UK.*

Currently used estimates of stoichiometric parameters of VFA production with rumen fermentation of feed components have been shown to be inaccurate for dairy cows. The goal of this study was to obtain improved estimates using lactating cow data only. A previously published model was used to estimate the fraction of 5 types of feed substrate converted into 4 types of VFA. These parameters were fitted using regression techniques by minimizing the difference between predicted and observed VFA molar proportions. Inputs to the model were observed amounts of ruminally digested substrate and model outputs were VFA molar proportions. In vivo data on rumen digestion of 108 diets were selected from literature. To test accuracy of the estimation method, data were simulated with an arbitrarily chosen set of parameter values. Re-estimated parameters deviated less than 0.5% of their original value, except for parameters < 0.1 or related to protein fermentation. With in vivo data, a systematic deviation between observed and predicted VFA molar proportions occurred. This result indicates that other factors are to be included to reduce residual variation. Compared to currently used estimates, however, estimates in the present study may be more representative of fermentation conditions in lactating dairy cows.

Substrate	Acetate		Propionate		Butyrate	
	C	R	C	R	C	R
SC	.60(.01)	.64(.02)	.12(.01)	.13(.02)	.26(.01)	.23(.01)
ST	.55(.01)	.53(.01)	.28(.01)	.21(.01)	.16(.01)	.21(.01)
HC	.51(.01)	.45(.03)	.12(.01)	.22(.02)	.35(.02)	.32(.01)
CE	.77(.02)	.60(.03)	.12(.01)	.20(.02)	.11(.02)	.19(.02)
P	.26(.06)	.79(.06)	.46(.04)	.13(.05)	.28(.06)	.08(.04)

Standard deviation in parenthesis obtained by 20 jack-knife runs; C, R = concentrate diet, roughage diet; SC, ST, HC, CE, P = soluble carbohydrates, starch, hemi-cellulose, cellulose, protein.

Key Words: Dairy Cattle, VFA, Modeling

1234 Transforming feed composition data to input data required by a dynamic, metabolic model of a dairy cow. H. A. Johnson*, L. M. Crocker, and R. L. Baldwin, *University of California, Davis.*

A computer program written in Visual Basic estimates nutrient inputs for AaMOLLY, a dynamic, mechanistic model of a dairy cow written in the advanced, continuous simulation language (ACSL). The program formulates diets for AaMOLLY from a built in feed list and contains equations to convert conventional nutrient analyses to nutrient inputs required by AaMOLLY. New feeds can then be added to the feed list. Feed nutrient analyses were compiled from the literature and lab analyses to create a feed list of 156 feeds. The feed list was used to develop equations to estimate soluble carbohydrates (SC), organic acids (OA), pectin (PE), and starch (ST) on a kg per kg basis. Nutrient inputs required are neutral detergent fiber (NDF), crude protein (CP), insoluble ash (AI), plant lipid (LI) and animal lipid (FAT). ST was regressed on (1-NDF-CP-AI-LI-FAT) and SC and PE were regressed on (1-NDF-CP-AI-LI-FAT-ST) with no intercepts. The regression coefficients were 0.82, 0.39 and 0.53 with coefficients of determination of 0.76, 0.73 and 0.79 for ST, SC and PE, respectively. Regression coefficients were significantly different from zero at 95% level of confidence. Since each feed nutrient analysis must sum to one and limited data was available to estimate organic acids, the coefficient for OA was estimated from the remainder (1-0.39-0.53 equals 0.08). Results indicate that current feed composition data can be converted to the diet input information required to run a complex dynamic model of dairy cow metabolism.

Key Words: Nutrient Analysis, Dairy Cow Model

1235 Diet fibrosity and dynamic of liquids in the rumen of cattle. D. Sauvart^{*1} and D. Mertens², ¹INRA-INAPG, Paris, France, and ²US DAIRY FORAGE CENTER, Madison, WI.

To elucidate the relationship between dietary fiber and dynamic of liquid flow in the rumen a database of was compiled from 79 publications and 126 trials with growing and lactating cattle. This database contains information about dry matter intake ($n = 336$, DMI = 14.8 ± 6.3 kg/d), diet proportion of concentrate ($n = 336$, PCO = 34.0 ± 24.5 %), NDF content ($n = 318$, 42.8 ± 13.6 %DM), mean particle size ($n = 48$, MPS = 2.65 ± 1.55 mm). In addition total chewing time ($n = 143$, CT = 669 ± 225 min/d), index of mastication ($n = 143$, IM = 47.4 ± 31.1 CT/kg DMI), eating ($n = 143$, ET = 279 ± 114 min/d) and ruminating ($n = 143$, RT = 390 ± 141 min/d) times were summarized. Data on liquid were rumen volume ($n = 235$, RV = 70.7 ± 20.9 l), liquid outflow rate ($n = 227$, LOR = 171.9 ± 68.8 l/d) and fractional LOR ($n = 286$, kl = 10.7 ± 3.4 %/h). Statistical analyses were performed globally and within the trials to extract more generalisable laws.

Level of NDF intake (NDFI, $n = 318$, 5.51 ± 1.88 kg/d) was the variable mostly globally correlated with RV ($R = 0.61$) and the within trial ($n = 90$) equation was calculated (RV = 5.0 NDFI + 42.9 , $R = 0.96$, $rsd = 7.11$, $n = 231$). Within the trials ($n = 77$), LOR was linearly dependant on RV (LOR = 3.23 RV - 52.1 , $R = 0.97$, $rsd = 22.7$ l/d, $n = 197$). NDFI was also the best dietary predictor of LOR (LOR = 23.2 NDFI + 43.2 , $rsd = 25.6$ l/d, $n = 216$). The within trial relationship between LOR and DMI was significantly quadratic (LOR = -0.46 DMI² + 24.2 DMI - 64.0 , $R = 0.93$, $rsd = 24.0$ l/d, $n = 227$) and exhibited a maximum equal to 264.4 l/d for DMI = 26.2 kg/d. Ruminating time (RT) was also a good predictor of LOR, particularly within trials (LOR = $129.5 + 0.185$ RT, $R = 0.94$, $rsd = 25.4$ l/d, $n = 85$). The corresponding equations for eating and chewing times were less accurate.

Throughout the various relationships NDF diet content or intake appeared as the best parameter to predict liquid dynamics in the rumen of cattle.

Key Words: Diet Fibrosity, Kinetic of Liquid, Rumen

1236 Comparison of methods for estimating ruminal rate of passage and ruminal rate and extent of fiber digestion in high grain diets. K. M. Krause* and K. A. Beauchemin, Agriculture and Agri-Food Canada, Research Center, Lethbridge, AB, Canada T1J 4B1.

The objective of this experiment was to compare a rumen evacuation technique with *in situ* and marker (Cr-mordanted fiber) techniques for estimating digestion and passage kinetics of NDF. Four ruminally cannulated steers were fed one of four feedlot finishing diets for ad libitum intake in a 4×4 Latin square experiment. Diets were based on barley grain (>90%), barley silage, and increasing levels of beet pulp (0, 3, 6, 9%) on dry matter basis. Digestion kinetics were determined by *in situ* incubation and rumen evacuation. Passage kinetics were estimated from the exponential decline in fecal Cr concentration, using a model with two age independent compartments and a time delay, and the rumen evacuation technique. There was no significant effect of diet on any of the parameters estimated. Ruminal passage rates (k_p) estimated from the exponential decline in fecal Cr were considerably higher (0.041 vs 0.018 h⁻¹; $P = 0.0001$) and ruminal retention time ($1/k_p$) was lower (25 vs 56 h;) compared to those based on the rumen evacuation technique. Higher passage rates obtained using the marker technique were attributed to the lack of age-dependency in the model. Deriving rate of passage from rumen evacuation data takes into account the retention in both the age-dependent (non-escapable) and age-independent (escapable) NDF pool. Rate of digestion was higher using the rumen evacuation technique compared to the *in situ* technique (0.074 vs 0.053 h⁻¹; $P = 0.15$). Despite differences in rates of passage and digestion, rumen NDF digestibility (RNDFD) was similar when calculated using *in situ* digestion data combined with the exponential decline in fecal Cr or rumen evacuation data (37.9 vs 38.3%). However, both estimates of RNDFD were only 0.72 to 0.74 of total *in vivo* NDF digestibility.

Key Words: Cattle, Digesta Passage Kinetics

1237 Evaluation of nutritional factors influencing milk urea concentrations. K. J. Shingfield* and P. Huhtanen, Agricultural Research Centre, Jokioinen, Finland.

Mean treatment data derived from 18 production trials in which cows were fed 133 diets was used to evaluate the nutritional factors affecting milk urea concentrations (MUC). Single factors that gave the best prediction of MUC were crude protein (CP) intake per unit metabolizable energy (ME) intake ($r^2 = 0.619$) and CP content ($r^2 = 0.598$). Taking between-experiment variations into account improved these relationships (r^2 values 0.725 and 0.722, respectively). Multiple regression analysis was used to establish which nutritional factors gave the best prediction of MUC. Prediction based on ME content, CP content, ratio of CP to ME intake, protein balance in the rumen (PBV) content and the ratio of PBV to ME intake ($r^2 = 0.755$) was not substantially improved by the inclusion of additional factors. Further examination of the data indicated that within normal ranges of MUC currently described in Finland by values of between 20 to 30 mg/100ml, dietary CP content varied markedly between 13.1 and 18.3%. This data indicates that advisory MUC should not be considered to be absolute and that improvements in on-farm nitrogen utilisation based on MUC measurements, require within-farm group feeding or herd assessments.

Key Words: Milk Urea Concentration, Nitrogen Utilisation

1238 Comparison of starch methods for analysis of feedstuffs. M. B. Hall*¹, J. P. Jennings¹, B. A. Lewis², and J. B. Robertson³, ¹Dept. of Dairy and Poultry Sci., Univ. of Florida, Gainesville, ²Div. of Nutr. Sci., Cornell Univ., Ithaca, NY, ³Dept. of Animal Sci., Cornell Univ., Ithaca, NY.

The effects of solubilization and sample preparation methods on analysis of starch were studied. Corn starch was analyzed directly and after extraction with 90% ethanol. Four methods of starch gelatinization and digestion were compared: A. Digestion with heat-stable α -amylase (Termamyl 120L) in water at 90°C; B. Sequential treatment with Termamyl at 90°C, 4N KOH at room temperature, and neutralization with 4N HCl; C. Gelatinization and digestion at 90°C in 8M urea containing Termamyl; D. Gelatinization and digestion at 90°C in 6M urea. Aliquots were digested further with amyloglucosidase and assayed for glucose by the glucose oxidase method. The significance level used in statistical analyses was $P < .05$ and least squared means are reported. Starch values (%) were higher for the unextracted starch by methods A and B (95.7 and 94.7%) than with methods C and D (92.5 and 93.5%). The 90% ethanol extracted starch values were lower but showed the same trend (A and B, 92.2 and 92.6%; C and D, 88.6 and 86.9%). Samples of potato starch, confectioners sugar, soybean meal, citrus pulp, distillers grains, hominy feed, a total mixed ration, and corn starch with added glucose, fructose or cellobiose were analyzed directly and after extraction with 90% ethanol. Within method A, higher starch values were found for unextracted than for ethanol-extracted samples. Samples containing glucose or sucrose gave falsely high starch values, unless extracted with ethanol prior to analysis. Ethanol-extracted samples gave higher values by method B compared with A. Accurate starch analyses may require preextraction of interfering compounds and gelatinization with KOH or other base.

Key Words: Starch, NSC, Carbohydrate

1239 Effects of glycerol versus starch in mixed diets on ruminal fermentation and digestibility in cattle. A. Schröder* and K.-H. Südekum, *University of Kiel, Germany.*

This study was conducted to compare glycerols of different purities with starch as rapidly fermentable carbohydrate sources in mixed diets as related to ruminal fermentation and whole-tract digestibilities. Four ruminally cannulated Angler Rotvieh steers were utilized in a 4 × 4 Latin square design. They were fed on a 40:60 forage (grass silage):concentrate diet (dry matter (DM) basis) at 85% of ad libitum intake. The pelleted concentrates were isonitrogenous and isoenergetic and contained no glycerol or 15% glycerol from technical glycerol of different purities (60, 80, 100% glycerol in the product). Starch contents in mixed diet DM were 16.1, 10.5, 10.3, and 10.1%, respectively. Rumen ingesta were quantitatively evacuated at 0200, 0900, 1400, and 2100 to estimate rumen pool sizes and *in vivo* fermentation of fiber fractions. Whole-tract digestibilities of organic matter (OM) constituents were estimated from feed and fecal concentrations of titanium(IV)-oxide. Digestibilities of OM, Neutral Detergent Fiber (NDF) and starch were not different ($P > 0.10$) between diets and averaged 72.1, 65.1, and 98.3%, respectively. For all diets, postprandial pH values in ruminal fluid were always higher than 6.2. Feeding glycerol as compared with starch resulted in a reduced ($P < 0.05$) ratio of acetic acid to propionic acid in ruminal fluid for almost all of hourly sampling times over 24 h. Daily water intake, variables of rumen fill, and bacterial DM concentrations in ruminal fluid were not influenced ($P > 0.10$) by dietary treatment. Estimated rates of *in vivo* ruminal fermentation of NDF and Acid Detergent Fiber were not affected by type of diet ($P > 0.10$; mean 52 and 43%/day, respectively) and hence ruminal fiber degradation was not impaired when glycerol was substituted for starch in the concentrate portion of the diet. We conclude that glycerol can be substituted for rapidly fermentable starch sources, e. g. wheat or tapioca, in cattle diets without negative effects on ruminal nutrient turnover and digestibilities of OM constituents in the whole tract.

Key Words: Rumen, Digestibility, Glycerol

1240 Starch digestion and utilization in ruminants. Z. Shabi^{1*}, I. Bruckental², Y. Aharoni², S. Zamwel¹, H. Taguri¹, and A. Arieli¹, ¹*Hebrew University, Rehovot, Israel.* ²*Volcani Center, Bet Dagan, Israel.*

Four Holstein cows (milk yield 26 ± 0.32 kg/d) were fitted with ruminal and abomasal cannulas to study the effect of feeding high-NSC diets in two feeding frequencies (2 vs. 4) on CP and NSC digestibility's in dairy cows. Diets contained 40% corn grain, 7.5% soybean meal, 12.3% vetch hay, 36.5% corn silage, 1% premix urea. In the second diet half of the ground corn was replaced by extruded corn. Diet composition was 14% CP, 55% NSC and 31% NDF. External marker (Cr-mordant, 2 g/d) was supplied to evaluate nutrients flows and digestibilities. Samples, taken from abomasal cannula every 1.5 h and from feces 6 times during the sampling period, were analyzed for CP, NSC, and Cr content. Intake of CP was 2.5 ± 0.03 kg/d, CP flow to the abomasum was 2.4 ± 0.1 kg/d, microbial CP flow to the abomasum was 1.8 ± 0.1 kg/d and total tract digestion of CP was $66.3 \pm 3.1\%$. Flows of CP and non-microbial CP were increased when cows were fed 4 vs. 2 meals. Flow of microbial CP to the abomasum was not effected by feeding frequency and by the diets. Intake of NSC was 10.0 ± 0.6 kg/d, post ruminal digestion (PRD) of NSC was 4.1 ± 0.4 kg/d and total tract digestion of NSC was $91.5 \pm 1.5\%$. Higher PRD of NSC was observed when cows were fed the extruded corn diet or/and four meals daily. Crud protein flow to the abomasum was related to PRD of NSC as follows: NSC disappearance (%) = abomasal CP (% of intake) × 0.38 + 44.4, $R = 0.54$, $P = 0.03$. A better correlation was found between non-microbial protein flow and PRD of NSC: NSC disappearance (%) = non-microbial CP flow (% of intake) × 0.37 + 71.2, $R = 0.62$, $P = 0.01$. Post ruminal disappearance of NSC was not affected by microbial CP flow. It suggested that increase in escape protein flow to the abomasum might affect pancreatic enzyme secretion, which in turn may increase PRD of NSC. When high-starch diet is fed, increase of dietary rumen escape CP and increase of feeding frequency should be considered.

Key Words: Starch, Intestine, Dairy Cows

1241 Changes in sorghum and corn grains during steps in the steam-flaking process. R. L. Preston, *Texas Tech University, Lubbock.*

Steam-flaking (SF) is the processing method of choice for sorghum grain (SG) and is commonly used in commercial cattle feedlots. Corn is also often steam-flaked but the efficiency benefits are less than with SG. Enzymatic (amylglucosidase) available starch (AS) is a more sensitive measure of changes in starch than is starch gelatinization (birefringence), especially at higher degrees of SF (decreasing density). Steam-flaked SG has been the standard grain/processing method used at the Texas Tech Burnett Center and over the years, six experiments were conducted to measure changes that take place during the SF process (dry-unprocessed, conditioned, steamed, flaked, cooled, stored) using an air-lift system. All samples (n=136) were air-dried (cooled) for 48 h followed by grinding through a 1 mm screen. DM (100°C), total starch (TS) and AS (JAS 68:3861, 1990), soluble CP (.0025 and .005N NaOH), and CP, ash, P and K (AOAC) were determined. TS (% of DM) did not vary between flaking steps (72.6 ± 1.54). AS (% of total starch) was similar through the steaming step (31.8 ± 4.66), after which it increased (80.8 ± 6.04). AS between lots of dry-unprocessed SG ranged from 25 to 42% of TS indicating considerable initial variation. CP (% of DM) did not vary across flaking steps ($10.6 \pm .182$). Soluble CP (% of CP) was similar for unprocessed and conditioned grain (27.7 ± 2.82) but decreased with steaming and subsequent steps (8.6 ± 1.43). Ash, P and K remained constant through steaming (1.62, .234 and .286% of DM, respectively) but decreased with flaking (1.39, .179 and .238% of DM, respectively). Ash also decreased with decreasing density of steam-flaked SG. P and K were correlated with ash ($r = .64$ and $.81$, respectively). TS and CP did not vary significantly during the flaking steps. Soluble CP decreased with steaming whereas AS increased only after flaking, implying that starch granule changes take place at two different steps in the flaking process. Ash, P and K decreased 14, 23 and 17%, respectively, during the flaking step, the explanation for which is not apparent. Limited observations (n=4) with steam-flaked corn showed increases in TS and AS, and decreases in CP and ash with decreasing density.

Key Words: Sorghum Grain, Grain Processing, Steam-Flaking

1242 Effects of Planting Density and Processing Method on the Digestibility of Grain Sorghum by Ruminants. P. J. Defoor^{1*}, M. L. Galyean², N. A. Cole³, ¹*West Texas A&M University, Canyon, TX,* ²*Texas Tech University, Lubbock, TX,* and ³*USDA-ARS, Bushland, TX.*

Ten Saint Croix wethers were used in two 5 × 5 Latin square digestion trials to determine the effects of grain sorghum (Pioneer-8699) planting density and subsequent processing method on apparent dry matter and N digestibility (DMD and NDIG, respectively), starch digestibility (SD), and retention of P (PR) (as a percentage of intake) by ruminants. Diets contained either high-density (HD) or normal-density (ND) grain sorghum (38 or 76 cm rows, respectively) processed by dry-rolling (DR), steam-flaking (SF) (.36kg/L), or high-moisture ensiling (HM) to give the following treatments: 1) HM/HD, 2) HM/ND, 3) SF/HD, 4) SF/ND, 5) DR/ND. Grains processed by high-moisture ensiling were harvested at 30 before ensiling. Diets fed in Trials 1 and 2 contained 40 and 10 roughage, respectively, and were formulated to meet all nutrient requirements. At the beginning of each period, lambs were adjusted to their respective diets for 16 d. Feces, urine, and feed refusals were then collected, weighed, and composited over the following 5 d. Digestibility and retention data were analyzed by analysis of variance as a 5 × 5 Latin square design. The effects of processing method on digestibility and retention tended to be greater than the effects of planting density. Results are presented below:

TRIAL	TRT	%DMD	%SD	%NDIG	%PR
1	HM/HD	74.15 ^a	98.01 ^{ab}	67.25 ^a	18.73 ^a
1	HM/ND	73.31 ^a	98.41 ^{ab}	66.84 ^{ab}	13.88 ^{ab}
1	SF/HD	72.99 ^a	98.15 ^{ab}	62.50 ^c	13.78 ^{ab}
1	SFND	73.67 ^a	98.44 ^a	63.85 ^{bc}	9.04 ^b
1	DRND	74.07 ^a	97.85 ^b	67.13 ^a	14.30 ^{ab}
1	SEM	.42 ^d	.14 ^d	.74 ^d	1.53 ^d
2	HM/HD	83.17 ^a	99.27 ^a	72.72 ^{ab}	17.68 ^a
2	HM/ND	83.54 ^a	99.22 ^a	74.80 ^a	14.47 ^a
2	SF/HD	84.25 ^a	99.39 ^a	68.43 ^c	18.39 ^a
2	SFND	83.06 ^a	99.10 ^{ab}	69.92 ^{cb}	13.39 ^a
2	DRND	84.20 ^a	98.87 ^b	73.73 ^{ab}	15.14 ^a
2	SEM	.51 ^d	.06 ^d	.98 ^d	2.18 ^d

^{a,b,c}Means within a column lacking a common superscript differ ($P < .05$).
^dValues for SEM represent the pooled standard error of the mean.

Key Words: Grain Sorghum, Planting Density, Ruminants

1243 Ruminal parameters and kinetics of digestion of lactating dairy cows fed diets with either dry-rolled (DR) or steam-flaked (SF) sorghum and different levels of alfalfa hay (AH). L. G. Nussio, J. T. Huber*, C. B. Theurer, C. B. Nussio, and J. P. Santos, *University of Arizona*.

Four cannulated Holstein cows were assigned to a 4x4 LS design. During the experimental periods, 18d each, cows received one of the following diets: DR-HF (high forage); DR-LF (low forage); SF-HF; SF-LF with NDF/RDS ratios ranging from 2.7 to 1.4 and an NFC content of 44.3 to 37.5%. After 10 d adaptation, ruminal samples for pH, VFA and ammonia were taken every 4h during the 4 d collection period. At day 5, labelled feed ingredients (Yb,Dy,Co) were added to the rumen and fecal samples were taken every 6h during 72h. Ruminal pH was lower on SF than DR diets, mainly when LF was included. Ammonia levels were high, but tended to be lower on SF-LF diets. There was a decreased c2/c3 at the lower NDF/RDS ratios, because of a increase of c3. AH left the ruminal compartment at a faster rate (Kp) on LF than HF diets, mainly when SF was fed; whereas, SF grain tended to leave the rumen faster than the DR, mainly on LF diets. Passage rates (Kp) of liquid phase (Co-EDTA), was reduced by LF, mainly on SF diets.

DIETS					
Parameters	DR-HF	DR-LF	SF-HF	SF-LF	SEM
DMI Kg/d	16.5 ^b	17.4 ^{ab}	18 ^{abd}	19.8 ^{ac}	0.81
pH	6.13 ^a	6.12 ^a	6.00 ^b	5.9 ^b	0.04
Ammonia-N, mg/dL	27.1 ^c	27.2 ^c	27.0 ^c	25.3 ^d	0.89
C2, mM	95.1	100.6	100.7	97.3	3.70
C3, mM	22.5 ^c	23.6 ^c	27.2 ^b	30.0 ^a	1.15
C2/C3	4.24 ^a	4.40 ^a	3.72 ^b	3.31 ^b	0.09
Turnover rate, %/h	10.56	12.13	10.21	12.04	1.57
Kp AH, %/h	6.10 ^b	7.70 ^a		79.7 ^{cd}	0.01
Kp grain, %/h	7.26	7.77	7.81	7.97	0.56
Kp liquid, %/h	12.7 ^a	10.3 ^{ab}	10.6 ^{ab}	8.2 ^b	1.0

Means not sharing the same superscript ^{ab}(P<0.1);^{cd}(P<0.2)

1244 NDF levels and ruminally degradable starch (RDS) on *in situ* degradation rate and effective degradability (ED) of nutrients in lactating dairy cows fed sorghum diets. L. G. Nussio*, J. T. Huber, C. B. Theurer, C. B. Nussio, and J. P. Santos, *University of Arizona*.

Four cannulated cows were fed diets with 49(HF) or 39%(LF) alfalfa hay(AH), with 32 or 40% steam-flaked(SF) or dry-rolled(DR) sorghum in a 4x4 LS design (4 18d period). After adaptation, duplicate polyester bags were incubated in the rumen in a reverse sequence of time (96,72,48,24,12,6,0h) containing samples of AH, DR, SF, and the 4 diets(D)(NDF/RDS from 2.3 to 1.3). For both DM and NDF of AH, the fractional degradation rate (c) and ED were decreased at the lower ratios of NDF/RDS, mainly with SF diets. The HF had a decreased lag phase for NDF degradation. Grains showed higher c as the NDF/RDS was reduced. The ED was improved by 4.95% for DM and 7.5% for starch on SF. Lag time for both grain DM and starch were less on the lower NDF/RDS. At the intermediary NDF/RDS, DM and NDF had ED maximized; whereas, starch ED was 8.6% higher on SF than with DR diets. Rates of degradation for diets DM, NDF and starch were increased on SF diets by 33.9%, 48.9% and 84.6% respectively. By using TMR, the associative effect exert a negative impact over fiber degradation; whereas, it was positive for starch.

DIETS					
Parameters	DR-HF	DR-LF	SF-HF	SF-LF	SEM
Degradation rate (c), %/h					
AH-NDF	7.0 ^a	7.2 ^a	5.5 ^{ab}	3.5 ^b	0.21
G-starch	4.5 ^b	4.3 ^b	5.1 ^{ab}	6.1 ^a	0.6
D-NDF	2.2 ^b	2.5 ^{ab}	4.2 ^a	2.8 ^{ab}	0.7
D-starch	7.0 ^b	6.0 ^b	11.5 ^a	12.5 ^a	0.01
Effective degradability, %					
AH-NDF	51.8 ^a	47.0 ^{ab}	44.5 ^b	45.1 ^b	1.83
G-starch	72.7 ^b	73.3 ^b	78.9 ^a	78.0 ^a	0.84
D-NDF	35.5 ^b	46.6 ^a	47.6 ^a	36.9 ^b	2.4
D-starch	75.6 ^{cd}	73.3 ^d	82.0 ^c	79.7 ^{cd}	0.01

Means not sharing the same superscript ^{ab}(P<0.1);^{cd}(P<0.2)

1245 Effects of fineness of grinding and conservation method of corn grain on ruminal starch digestion kinetics in Holstein heifers before and after calving. Y. Ying* and M. S. Allen, *Michigan State University, East Lansing*.

The effects of fineness of grinding and conservation method of corn grain on ruminal kinetics of starch in Holstein heifers before and after calving were examined using 8 ruminally and duodenally cannulated animals in a duplicated 4 x 4 Latin square design. Corn grain was harvested from the same field, as high moisture corn at 65% DM, and as dry corn at 87% DM. Corn treatments were dry corn, ground finely or coarsely (mean particle size 810 μm or 4442 μm), and high moisture corn, ground finely or coarsely (mean particle size 1996 μm or 5633 μm), prior to feeding. Two experiments were conducted using the same animals before calving (beginning 137 ± 11 days prior to calving, mean DMI = 1.61% of BW) and after calving (beginning 39 ± 11 DIM, mean DMI = 3.33% of BW). Corn grain and alfalfa silage were the same for both experiments. Diets contained 62% alfalfa silage and 36% corn grain before calving and 49% alfalfa silage and 38% corn grain after calving. There was no effect of treatment on intake of DM or starch for either experiment. Rate of starch digestion and ruminal starch digestibility increased for high moisture corn compared to dry corn and for finely ground corn compared to coarsely ground corn for both experiments. High moisture corn also decreased rate of passage from the rumen for the experiment before calving. Fine grinding increased ruminal starch digestibility to a greater extent than high moisture conservation.

	Treatment				P value		
	DF	DC	MF	MC	C	G	CxG
Before calving							
Ruminal degraded starch, %	56.7	41.7	81.4	52.7	<0.01	<0.01	NS
Rate of starch digestion, h ⁻¹	21.6	9.8	27.5	22.8	0.02	0.05	NS
Rate of starch passage, h ⁻¹	16.0	13.9	9.3	12.0	0.02	NS	NS
After calving							
Ruminal degraded starch, %	63.2	36.8	76.3	47.8	0.02	<0.01	NS
Rate of starch digestion, h ⁻¹	22.8	7.6	33.7	16.1	0.01	<0.01	NS
Rate of starch passage, h ⁻¹	12.7	14.6	9.3	11.1	NS	NS	NS

DF: dry fine, DC: dry coarse, MF: high moisture fine, MC: high moisture coarse C: Effect of conservation method, G: Effect of fineness of grinding, CxG: Interaction of C and G

Key Words: Corn Processing, Ruminal Starch Digestion, Digestion Kinetics

1246 Influence of protein level, protein degradability and steam flaking of grain on production of milk and milk components by lactating dairy cows. L.J. Erasmus* and I. Smith, *Agricultural Research Council, ANPI, Irene, South Africa*.

One hundred and twenty multiparous Friesland/Holstein cows were utilized in a completely randomized design to evaluate level and degradability of dietary CP on performance of cows from calving till 170 DIM. Diets were formulated (DM) to contain 18.0% CP (HP) or 16.5% CP (LP) and were categorized as high (63 - 66% DIP) or low (56 - 58% DIP) degradable (HD, LD). Supplementary protein sources (% DM) in the eight alfalfa: corn based TMR's were: (1) 6 cottonseed meal (CSM), 6 sunflower meal (SFM), 2 corn gluten meal (CGM); (2) 7 SFM, 4 blood meal (BM); (3) 4 CSM, 4 SFM, 2BM, 3 meat-bone meal; (4) 7 fishmeal, 4 SFM; (5) 4 CGM, 4.5 BM; (6) 4 CGM, 4.5 BM; (7) 3.5 CSM, 3.5 SFM, 3 CGM; (8) 2 SFM, 2 CGM, 3 BM. Diet 6 differed from diet 5 only in that corn grain was partly replaced by steam flaked sorghum. Average values are given in the Table for HPHD (diets 1, 2, 3) and HPLD (diets 4, 5, 6) treatments. Amongst HP diets protein degradability did not affect milk production (P = .25) or DMI (P = .95). Increasing UIP content, however, elevated milk casein % (P = .01) and tended to increase milk protein % (P = .13). Amongst LP diets, cows receiving the high UIP diet produced more milk (P = .01) with increased casein % (P = .05). Consistent with previous results steam flaking increased milk by 2.4 kg/d (P = .03) and decreased milk fat % (P = .08). Results suggest for cows producing around 33kg/d, CP could be reduced to 16.5% of DM provided that UIP be at least 42% of CP and consideration is given to selective combinations of animal or marine byproducts and plant proteins having complementary AA profiles.

Item	HPHD				HPLD			Contrast, P=
	Diets 1-3	Diets 4-6	Diet 7	Diet 8	HPHD v HPLD	LPHD v LPLD	5V6	
DMI, kg/d	22.5	22.4	20.5	21.9	.95	.09	.01	
Milk, kg/d	33.2	34.0	30.9	33.6	.25	.01	.03	
Fat, %	3.30	3.23	3.35	3.20	.35	.27	.08	
Prot, %	3.02	3.09	3.02	3.02	.13	.99	.46	
Casein, %	2.25	2.29	2.17	2.23	.01	.05	.43	
NPN, %	0.23	0.22	0.22	0.21	.01	.37	.04	
MUN, mg%	18.7	17.5	18.5	17.1	.01	.05	.71	

Key Words: Protein Degradability, Dairy Cows, Steam Flaking

1247 Feeding value of barley varieties for finishing cattle. L. M. M. Surber*, J. G. P. Bowman, T. K. Daniels, T. J. Milner, A. L. Lewis, D. M. Coulson, and T. K. Blake, *Montana State University, Bozeman.*

Eighty crossbred steers (avg initial wt 365 kg) were allotted to 16 pens in a randomized complete block design to determine the effects of four barley varieties on feedlot performance, nutrient digestion, and carcass characteristics. Four diets based on: 1) Baronesse (BAR); 2) Lewis (LEW); 3) Morex (MOR); and 4) Steptoe (STE) barleys were balanced to be isonitrogenous (2.24% N), and isocaloric (1.39 Mcal NE_g/kg). Pen was the experimental unit in the 125-d experiment. Steers were weighed, and diet, ort, and fecal samples were obtained every 28 d. Diet and fecal samples were composited by pen and analyzed for DM, N, AIA, and starch. AIA was used as an internal marker to estimate fecal output and to calculate nutrient digestion. Steers were slaughtered when 70% were visually estimated to grade Choice. Hot carcass weight was used as a covariate for the analysis of carcass characteristics. Steers fed MOR were 19.7 kg heavier ($P = .09$) than those fed LEW or STE after 125 d. Average daily gain was 11% higher ($P = .06$) for MOR-fed steers compared with LEW- or STE-fed steers (1.61 vs avg 1.45 kg/d). Steers fed BAR were intermediate in final weight and ADG performance. Feed efficiency did not differ ($P > .10$) among diets (avg 16.8 kg gain/100 kg feed). No differences ($P > .10$) were detected between diets for any carcass characteristic (avg 318 kg hot carcass wt, 1.9% KPH, 1.1 cm fat thickness, 74.3 cm² longissimus muscle area, 2.9 yield grade, low choice quality grade). Digestible starch intake was greatest ($P = .004$) for MOR-fed steers (4.58 kg/d) compared with BAR- and LEW-fed steers (avg 4.22 kg/d), and least for STE-fed steers (3.67 kg/d). Barley variety influenced feedlot performance and nutrient digestion, however carcass characteristics were not affected. Morex, a malting variety, had superior feeding value for finishing steers compared with Baronesse, Lewis or Steptoe barleys.

Key Words: Barley, Feed Quality, Feedlot Performance

1248 Influence of dietary starch sources on ruminal fermentation characteristics of Holstein heifers. G. R. Khorasani^{1*}, E. Okine², R. Corbett², and J. J. Kennelly¹, ¹*University of Alberta, Edmonton, AB, Canada* and ²*Alberta Agriculture, Edmonton, AB, Canada.*

The hypothesis of this study was that dietary starch with different ruminal rates of degradation would affect the ruminal fermentation characteristics of Holstein heifers as indicated by rumen pH and volatile fatty acid changes. Four barley grain varieties (Brier, CD-Candle, Noble, and Oxbow) were compared to corn grain. The ruminal rate of DM degradation for Brier, CD-Candle, Noble, Oxbow and corn were 33.9, 29.0, 48.6, 47.9, and 6.5% per hour. Five Holstein heifers (546 ± 8.0 kg) were fed diet containing 35% barley silage and 65% concentrate. To equalize starch content in each of the test diets (approximately 33%), the barley diets contained 59% barley grain, whereas, the corn diet contained 51% corn in the total mixed ration. Five heifers were utilized in a 5 × 5 Latin square design and each experimental period was 2 weeks in length. Dry matter intakes were higher ($P = 0.09$) for animals fed the corn diet (10.6 kg/d) compared to those fed the Brier barley variety (7.7 kg/d), but did not differ among other dietary treatments. Mean pH of ruminal fluid was higher ($P < 0.05$) for heifers fed barley Oxbow variety (6.54) than for heifers fed barley Brier (6.05) or Noble (6.14) varieties, and no differences were observed for other dietary treatments. Average and maximum ruminal lactic acid concentration was lowest ($P < 0.05$) for animals fed corn and Brier, intermediate for animals fed barley Oxbow and CD-Candle varieties, and highest for animals fed the Noble variety. The rumen concentrations of acetate, propionate, valerate, and caproate were not affected by dietary treatments. Total ruminal volatile fatty acid's concentration was highest for animals fed the Noble variety, intermediate for animals fed corn, Brier and CD-Candle, and lowest for animals fed Oxbow. This study indicated that dietary starch source affects the ruminal fermentation characteristics as indicated by changes in rumen pH and volatile fatty acids.

Key Words: Starch Source, Rumen Fermentation Characteristics

1249 Using the carbohydrate B2 fermentation rate of western Canadian feedstuffs to evaluate the CNCPS model. C. A. Snyder*, A. F. Mustafa, and D. A. Christensen, *University of Saskatchewan, Canada.*

The objectives of this study were to determine the NDF fermentation rate of barley silages grown in western Canada and to compare the predicted (CNCPS) and actual production performance. Eight Holstein cows in early to mid lactation were fed a 55:45 forage : concentrate ration on a dry matter basis in a total mixed ration form using a double 4×4 Latin square design. The cows were fed total mixed rations containing either Lacombe barley silage, Bonanza barley silage, Lacombe barley plus Trapper pea silage or Lacombe barley silage plus alfalfa cubes. Analysis of the total mixed rations and dry matter intake, body weight, milk yield and milk composition of cows were entered into the CNCPS model. For the in sacco and in vitro incubation procedure a single non-lactating Holstein cow fitted with a flexible rumen cannula was utilized. NDF disappearance was measured in both procedures. NDF degradation rate (%/h) was not significantly ($P > 0.05$) different for the four silage treatments therefore values were averaged. The in sacco and in vitro incubation procedure resulted in NDF degradation rates of 1.09 %/h and 3.54 %/h respectively. The CNCPS library value for CHO B2 fermentation rate of barley silage is 10 %/h. For all three NDF degradation rates actual milk yield was highly correlated ($r \geq 0.70$) with ME allowable milk yield and moderately correlated ($r \geq 0.44$) with MP and AA allowable milk yield. All cows produced an average of 34.5 kg/day of FCM (3.5%) while DMI averaged 25.4 kg/day. The CNCPS model over-predicted milk yield (20%) and under-predicted DMI (10%). Replacing the barley silage CHO B2 fermentation rate of 10 %/h with 3.54 %/h resulted in a more accurate prediction of FCM (3.5%) yield than when using the rate of 1.09 %/h or 10 %/h. Results suggest that barley silage grown in western Canada may have a different CHO B2 fermentation rate than the barley silage contained in the CNCPS library.

Key Words: Barley Silage, Rumen, NDF Degradation

1250 Effect of grain hardness on in-situ degradation of corn and on milk production. I. Andrighetto¹, P. Berzaghi^{1*}, G. Cozzi¹, G. Magni², and D. A. Sapienza³, ¹*University of Padova, Italy*, ²*Pioneer Hi-Bred, Sissa, Italy*, ³*Pioneer Hi-Bred, Des Moines, IA.*

The objective of this study was to evaluate the effect of the source of corn grain on in-situ degradation and on milk production. Samples of three types of corn grain, hard (GCH; Pioneer[®] brand Costanza) and soft (GCS; Pioneer[®] brand Bianca) both finely ground (through a 2mm screen), and high moisture corn (HMC; Pioneer[®] brand Costanza) coarsely ground (100% cracked), were incubated at 6, 12, 24, 26, 48, 72, and 96 h in the rumen of two dry cows receiving a diet containing 10% (DM basis) of each treatment, GCH, GCS and HMC. Twelve primiparous lactating Holstein cows (42 d in milk) were used in a 3 × 3 Latin square design (21d period) replicated four times. Diets containing 30% (DM basis) of one of the three corn grain treatments were fed once a day as a TMR (CP 17.6 and NDF 30.6%DM). Intake and milk production were recorded daily. Milk, blood and rumen fluid samples were collected during the last week of each period. In-situ degradation was greater for CGS than CGH, but both were significantly lower than HMC. Results indicate grain hardness reduced in-situ degradability of corn grain in the rumen, possibly shifted starch degradation into the intestines, but did not affect DMI, milk yield or composition. Compared to CGH and CGS, HMC reduced DMI, milk fat, acetate(C2):propionate(C3) ratio, ruminal NH₃ and PUN.

Trait	GCH	GCS	HMC	SEM	GCH vs. GCS	Grain vs. HMC
In-situ DDM ¹ , %	59.2	65.8	81.4	2.9	0.01	0.01
DMI, kg/d	19.2	18.7	17.0	0.4	ns	0.05
Milk yield, kg/d	31.8	31.4	31.4	0.3	ns	ns
4% FCM, kg/d	29.8	29.8	28.4	0.6	ns	ns
Milk fat, %	3.60	3.70	3.38	0.10	ns	0.10
Milk protein, %	3.19	3.17	3.18	0.03	ns	ns
PUN, mg/dl	15.0	13.9	11.8	0.4	ns	0.01
Ruminal NH ₃ , mg/dl	11.4	9.0	6.8	1.1	0.10	0.01
C2:C3 Ratio	2.8	2.8	2.5	0.1	ns	0.10

¹DM degradation calculated at a passage rate of 5 %/h.

Key Words: Corn Grain Hardness, In-situ Degradation, Milk Production

1251 The effect of fibrolytic enzymes on the digestibility of dry rolled and tempered barley. S. P. Maki^{1*}, K. A. Johnson¹, and C. Hunt², ¹Washington State University, Pullman and ²University of Idaho, Moscow.

The effects of fibrolytic enzyme addition and barley processing method on ruminal fermentation and feed digestibility were examined using a 4 × 4 Latin Square design. The treatments were dry rolled barley (DRB), dry rolled barley with fibrolytic enzyme application (DRB+E), tempered barley (TB), and barley tempered in a fibrolytic enzyme mixture (TB+E). Four ruminally fistulated cows were fed an 80% barley, 20% alfalfa hay cube diet (DM basis; 9.2 kg DMI/d). The fibrolytic enzyme mixture (2:1 cellulase:fibrase) was applied at the rate of 2.4 L/T DM, diluted in 10 L of H₂O/T DM, to dry rolled and whole barley 16 h prior to feeding. For the TB and TB+E diets, H₂O was added to whole barley 16 h prior to feeding to yield a moisture content of approximately 18%. The tempered barleys were rolled just prior to feeding. The final average moisture content of the tempered barleys was 15% compared to 10% for the dry rolled barleys. Animals were initially adapted to the barley diets for 35 d. Subsequent adaptation periods were 14 d. Ruminal pH was measured every 3 h for 24 h. Respective barley treatments and forage samples were incubated for 8, 16, 24, 32, and 40 h *in situ* to evaluate ruminal DM disappearance. Barley processing or the application of fibrolytic enzymes did not affect ruminal pH although TB+E tended to have the lowest pH (DRB, 6.05; DRB+E, 6.19; TB, 6.19; and TB+E, 5.96 ± .05). There was no treatment effect or time × treatment interaction on ruminal DM disappearance of the forage portion of the diet. Average DM disappearance over all incubation times of the alfalfa was DRB, 46.5; DRB+E, 44.76; TB, 45.13; TB+E, 45.54 ± .9%. Tempered barley treated with the fibrolytic enzyme mixture tended (P=0.10) to increase ruminal DM disappearance of barley (DRB, 62.1; DRB+E, 54.1; TB, 63.7; TB+E, 69.2 ± 1.4%). The TB+E treatment increased ruminal DM digestibility, which is reflected by lower ruminal pH's. Tempering barley in a fibrolytic enzyme mixture may enhance nutrient utilization.

Key Words: Fibrolytic Enzymes, Barley, Tempering

1252 Effects of fibrolytic enzyme additives on milk production of dairy cows. W. Z. Yang, L. M. Rode, and K. A. Beauchemin*, *Agriculture and Agri-Food Canada, Lethbridge, AB, T1J 4B1.*

Twenty multiparous lactating Holstein cows in early lactation were used to investigate effects of supplementing dairy cow diets with exogenous fibrolytic enzymes on DMI, milk production and digestibility. Cows were blocked according to parity, expected calving date, and milk yield in the first lactation, and then randomly assigned to two treatments: control (C) or enzyme (E). Diets were balanced to provide metabolizable energy and metabolizable protein for 35 kg of milk using the CNCPS model. Diets contained 25% corn silage, 15% alfalfa hay, and 60% concentrate (DM basis) based on steam-rolled barley grain, and were offered as a TMR three times daily for ad libitum intake. The enzyme mixture contained mainly xylanase and cellulase activities (Pro-Mote[®], Biovance Technol. Inc., Omaha, NE). The enzyme mixture was diluted 5-times with water and added into the concentrate at the time of manufacture (2 g enzyme mixture/kg concentrate DM). Total tract digestibility was determined using a Cr₂O₃ marker. Dry matter intake was not affected by enzyme addition (E vs C; 19.0 vs 18.7 kg/d), however enzymes increased milk yield by 10% (E vs C; 39.5 vs 35.9 kg/d; P<0.11). However, increased milk yield reduced milk components, such that component yields were similar (P>0.05) for cows fed enzyme-treated diets and cows fed the control diet (E vs C; protein, 1.19 vs 1.13 kg/d; fat, 1.32 vs 1.35; lactose, 1.85 vs 1.68 kg/d). Digestibility of nutrients in the total tract was dramatically increased (P<0.01) by enzyme treatment (E vs C; DM, 69.1 vs 61.7%; NDF, 51.0 vs 42.5%; ADF, 41.9 vs 31.7%; CP, 69.8 vs 61.7%), except for starch digestibility which was similar for the two diets (E vs C; 95.5 vs 94.1%; P>0.05). In addition, energy deficiency was numerically lower for cows fed enzyme-treated diets than for cows fed the control diet (3.33 vs 3.62 Mcal/d). These results indicate that adding an exogenous fibrolytic enzyme mixture to the concentrate of dairy cows in early lactation has the potential to enhance milk yield and nutrient digestibility with no effect on feed intake. However, inadequate nutrient intake likely prevented a corresponding increase in the synthesis of milk components.

Key Words: Feed Enzymes, Digestibility, Lactation

1253 Pyruvate Carboxylase and Phosphoenolpyruvate Carboxykinase Expression in the Transition Dairy Cow. R. Greenfield^{*1}, S. S. Donkin¹, and M. J. Cecava², ¹Purdue University, West Lafayette, IN, ²Consolidated Nutrition, L.C., Fort Wayne, IN.

Lactation greatly increases the demand for gluconeogenesis in dairy cattle and the inability to meet this demand is often associated with metabolic disorders in the transition dairy cow. Pyruvate carboxylase (PC) and phosphoenolpyruvate carboxykinase (PEPCK) are potential rate limiting enzymes for gluconeogenesis from lactate and propionate. To investigate the role of these enzymes in glucose metabolism in the transition dairy cow, liver biopsy samples were obtained from 10 multiparous Holstein cows beginning 28 days prior to expected calving and continuing to 56 days in milk (DIM). Cows were fed according to National Research Council requirements for dry and lactating cows. Liver biopsies and plasma samples were obtained on days -28(actual -29 ± 4d), -14(actual -15 ± 4d), +1, +28, and +56, relative to calving. Liver samples (250 mg) were analyzed by Northern blotting for abundance of mRNA corresponding to PC and PEPCK. Abundance of 18S rRNA was used to adjust for variation in loading and transfer. Liver PEPCK expression was significantly higher at 28 DIM than at -28, -14, or +1 DIM (159%, 181%, and 143%, P < 0.05), but not different than +56 DIM. PC expression was significantly higher at 1 DIM than -28, -14, +28, and +56 DIM (271%, 214%, 171%, and 242%, P < 0.05). Plasma glucose values were lower on +1 DIM than -28, -14, and +56 DIM (48.0 mg/dl vs. 60.3, 59.5, and 60.5 mg/dl, P < 0.05), but not different than +28 DIM. The data suggests that PC may play a critical role in regulating gluconeogenesis during the transition period, while PEPCK may be more important later in lactation. Low blood glucose or associated metabolic changes, due to the intake depression observed around calving, may precipitate increases in PC expression. Elevated PC expression indicates a greater potential use of lactate as a gluconeogenic substrate during the transition to lactation compared with other times during lactation or the dry period.

Key Words: Dairy Cattle, Pyruvate Carboxylase, Phosphoenolpyruvate Carboxykinase

1254 Supplementation of propylene glycol to dairy cows in periparturient period: effects on plasma concentration of BHBA, NEFA and Glucose. L. F. Laranja da Fonseca*, C. S. Lucci, P. H. M. Rodrigues, M. V. Santos, and A. P. Lima, ¹Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil.

The risk of metabolic problems in dairy cows at early lactation is close related to the occurrence of negative energy balance during periparturient period. A strategy that could be used to prevent the occurrence of this problem is the supplementation of the diet with energetic compounds at early lactation. The objective of this study was to evaluate the effects of propylene glycol (PPG) supplementation to dairy cows in the periparturient period on BHBA, NEFA and Glucose plasma concentration. Twenty-three Holstein cows were blocked by parity and assigned randomly to two groups: PPG (11 animals) and Control (12 animals). The animals received 300 ml of PPG or Water (placebo) via drench on days -10, -5, -4, -3, -2, -1, 0, 2, 4, 6, 8, 10, 12, 14 and 16 relative to calving date. Plasma samples were collected during days -10, -5, 0, 3, 7, 14, 21, 28, 35, 42 and 49 relative to calving date to analyze Beta-hydroxybutyrate (BHBA), non-esterified fatty acid (NEFA) and Glucose (Glu). There was no effect of treatment or interaction of time × treatment on plasma parameters (BHBA, NEFA, Glu) but there was an effect (P < 0.05) of time on Glu and NEFA.

Variable	Control	PPG	CV	P
BHBA* (mg/dl)	6.73	4.80	80.70	0.2389
NEFA* (uEq/l)	414.98	383.96	70.80	0.9058
Glucose* (mg/dl)	65.44	66.00	21.31	0.8865

* Average of 11 samples collected from -10 to 49 days to calving date.

In conclusion, supplementation of PPG to periparturient dairy cows was not effective to alleviate the negative metabolic effects that normally occur at early lactation.

Key Words: Dairy Cows, Propylene glycol, Nutrition

1255 **Supplementation of propyleneglycol to dairy cows in periparturient period: effects on incidence of ketosis and ketosis' consequence on milk yield, body condition score and first estrus post-partum.** A. P. Lima*, L. F. Laranja da Fonseca, C. S. Lucci, P. H. M. Rodrigues, and M. V. Santos, *Faculdade de Medicina Veterinária e Zootecnia/Universidade de São Paulo, Brazil.*

Negative energy balance at early lactation can determine the occurrence of metabolic disorders like fatty liver and ketosis. Consequently these disorders may affect milk yield and reproduction performance of dairy cows. One strategy that could be utilized to minimize the risk of occurrence of metabolic disorders is supplementation with gluconeogenics compounds during early lactation. The objective of this study was to evaluate the effects of propyleneglycol (PPG) supplementation to periparturient dairy cows on the occurrence of ketosis in early lactation and its consequences on milk yield, body condition score (BCS) and interval from calving to first estrus. Twenty-three Holstein cows were blocked by parity and assigned randomly to two groups: PPG (11 animals) and Control (12 animals). All animals received 300 ml of PPG or water (placebo) via drench on days -10, -5, -4, -3, -2, -1, 0, 2, 4, 6, 8, 10, 12, 14 and 16 relative to calving date. Plasma samples were collected during days -10, -5, 0, 3, 7, 14, 21, 28, 35, 42 and 49 to calving date to analyze Beta-hydroxybutyrate (BHBA). All cows, which average BHBA plasma concentrations were higher than 10 mg/dl during three samples in a row were defined as ketotic. BCS was evaluated in days -10, 0, 15, 30, 45 and 60 to calving date and milk yield was measured weekly from second to twelfth week of lactation. Interval from calving to first estrus was evaluated by radiotelemetric device system (HeatWatch). Considering BHBA concentration as an indicator of ketosis, the incidence of this metabolic disorder was 33.5% (4/12) and 9.1% (1/11) in Control and PPG group, respectively, but this difference was not statistically significant. It was observed a significant effect of ketosis on BCS variation from calving to 60 days post-partum and a tendency on milk yield and interval to calving to first estrus post-partum.

Variable	Ketosis n=5	Normal n=18	C.V.	P
10 estrus post-partum	51.60	40.33	26.91	0.0503*
Variation of BCS	1.500	1.028	40.49	0.0380**
Milk Yield (Kg/cow/day)	20.36	25.62	23.73	0.0721*

* P < 0.10
* P < 0.05

Key Words: Propyleneglycol, Dairy Cows, Nutrition

1256 **Supplementation of propyleneglycol to dairy cows in periparturient period: effects on body condition score, milk yield and first estrus post-partum.** C. S. Lucci*, L. F. Laranja da Fonseca, P. H. M. Rodrigues, M. V. Santos, and A. P. Lima, *Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Brazil.*

The negative energy balance during the peripartum period is one of the main factors that can affect milk yield and reproduction performance. The objective of this study was to analyze the effects of propylene glycol (PPG) supplementation to periparturient cows on: milk yield, changes in body condition score (BCS) and days to first estrus after calving. Twenty-three Holstein cows were assigned to two groups: PPG (11 animals) and Control (12 animals). The animals received 300 ml of PPG or Water (placebo) via drench on days -10, -5, -4, -3, -2, -1, 0, 2, 4, 6, 8, 10, 12, 14 and 16 relative to calving date. The milk yield was measured weekly from the second to twelfth week of lactation. The BCS was evaluated in days -10, 0, 15, 30, 45 and 60 relative to calving date. The first estrus post-partum was evaluated by radiotelemetric device system (HeatWatch). There was no effect of treatment or time on milk yield, although the interaction of time x treatment was significant and during the fourth and fifth weeks of lactation milk yield was significantly higher (P < 0,05) in treatment group. Days to first estrus of PPG and Control groups were 40.18 and 45.17 days, respectively, being statistically non-significant. There was no effect of treatment on BCS from calving to sixty days post-partum.

	Control	PPG	CV	P
BCS change (0/60 days)	-1.17	-1.02	39.09	0.3741
Days to First Estrus	45.17	40.18	26.91	0.3105
Milk Yield (Kg/cow/day)	24.53	27.03	20.55	0.2900

Key Words: Dairy Cows, Propyleneglycol, Nutrition

1257 **The influence of forage preservation method, concentrate level and propylene glycol on dry matter intake and milk production.** K. J. Shingfield*, S. Jaakkola, and P. Huhtanen, *Agricultural Research Centre, Jokioinen (Finland).*

The effects of forage preservation method, concentrate level and propylene glycol (PG) on dry matter (DM) intake and milk production were evaluated with 32 Finnish Ayrshire cows during four 21-d periods. Sixteen treatments consisting of four forages, two concentrate levels and either none or 210 g/d of propylene glycol (PG) were allocated according to a cyclic change-over design. Silages were prepared from a Timothy-Meadow Fescue sward, while hay was prepared from the same sward cut 7-d later. Silages were prepared using either no additive (UT) or those based on formic acid (FA) or a bacterial preparation (I). Forages were offered ad libitum. Concentrate formulated from barley, oats, sugar beet pulp and rapeseed meal (16.9 % CP) was offered as 7 (L) or 10 (H) kg feed/d. DM intake and milk yield was 19.2, 19.8, 20.2, 20.7 kg/d (SEM 0.15) and 25.8, 26.4, 27.0 and 27.1 kg/d (SEM 0.21) for hay, UT, I, and FA treatments, respectively. Increasing concentrate level significantly (P<0.001) increased DM intake (19.2 vs 20.7 kg/d) and milk yield (25.9 vs 27.2 kg/d). PG inclusion had no significant (P>0.05) effects on DM intake or milk production for silage-based diets. In contrast, PG significantly (P = 0.075) increased milk yield (26.2 vs 25.3 kg/d) but not DM intake (19.2 kg/d) for hay based diets. Comparisons between UT and hay diets indicated that higher milk yields could be attained by ensiling grass even in the absence of an additive, a finding which was consistent across both concentrate levels (25.8 vs 24.8 and 27.0 and 26.7 kg/d for L and H treatments, respectively). The current data also indicated that in order to achieve similar milk yields for hay and UT compared to FA and I based diets, an extra 3 kg concentrate feed/d would be required.

Key Words: Forage Preservation, Milk production

1258 **Plasma concentration of urea, ammonia, glutamine (gln) and glutamate (glu) around calving and their relation to liver triglyceride (TG) and plasma Ca.** L. H. Zhu*, L. E. Armentano, D. R. Bremmer, R. R. Grummer, and S. J. Bertics, *University of Wisconsin, Madison.*

Fatty liver decreases urea synthesis in vivo in the rat and in bovine hepatocytes in vitro and ureagenesis affects ammonia detoxification and pH homeostasis. We hypothesized that fatty liver could hamper hepatic conversion of ammonia to urea and increase circulating ammonia or glutamine in cows around parturition. Also decreased urea synthesis might cause alkalosis and in turn reduce blood calcium (Ca). Holstein cows (n=16) were monitored from d 27 prior to expected calving (-27d) to 35d postpartum (+35d). Animals were fed the same diet from d -27 to +2. Plasma was sampled at -27d, +12h, +16h, +22h and +35d. On d -27, +2 and +35, liver was biopsied and analyzed for TG. Data were analyzed as repeated measures. Time affected plasma ammonia (P<.0001), Ca (P<.0001), Gln (P<.05), Gln% [= Gln x 100/(Gln+Glu)] (P<.0001), ammonia/urea (P<.001) and liver TG (P<.01). Liver TG at 2d correlates with Gln% at 22h (r=.63, P<.05). Ca correlates with ammonia (r=-.82, P<.001), ammonia/urea (r=-.70, P<.05) and Gln (r=-.61, P<.05) at 22h. The rise in ammonia and Gln% at calving suggests an increase in ammonia passing to and through the liver. The negative correlation between Ca and ammonia is unrelated to hepatic TG accumulation.

Time to calving	Ammonia (uM)	Ca (mg/dl)	Urea (mM)	Gln (mM)	Gln% (%)	TG (% DM)
-27d	30.63	8.69	5.76	0.37	88.8	1.45
+12h	58.08	7.99	6.33	0.37	92.1	
+16h	63.12	7.31	6.20	0.33	90.2	
+22h/+2d	46.22	7.48	5.74	0.33	89.2	10.00
+35d	24.07	8.55	5.46	0.30	85.2	9.82
SE	5.4	0.25	0.32	0.024	1.1	2.4

Key Words: Liver Triglyceride, Plasma Ammonia, Plasma Glutamine

1259 Effect of Posilac withdrawal strategy on milk yield and body weight of late lactation dairy cows. D. K. Combs^{1*}, J. C. Byatt², and W. Wyeland², ¹University of Wisconsin-Madison and ²Monsanto Agricultural Sector, St. Louis, MO.

The objective of this study was to examine the effect of discontinuing use of bST (Posilac) 56 days prior to scheduled dry off on milk yield and body weight of dairy cows fed diets that are marginal in energy throughout lactation. Eighty eight multiparous Holstein cows were randomly assigned to three treatments. A Control group received no bST. A 'Normal bST' group received bST at two week intervals from week 9 of lactation to 14 days before scheduled dry off. An 'Early bST withdrawal' group received Posilac at two week intervals from week 9 of lactation to 56 days before scheduled dry off. All cows were dried off between 192 and 206 days of gestation. To facilitate reproduction, cows were synchronized according to the protocol of Wiltbank (1994) and bred during week 9 of lactation. Cows that were not pregnant by week 27 of lactation were dropped from the study. Fifty five cows (22 control, 20 Normal bST and 13 Early bST withdrawal) completed the experiment. All cows were initially fed ad libitum a diet that was calculated to be marginal in energy (1.72 Mcal Nel/kg). Cows were switched to a diet containing 1.62 Mcal Nel/kg if and when body condition began to increase and cows were switched again to a diet containing 1.42 Mcal Nel/kg if condition scores began to increase on diet two. Cows remained on the diet they were fed at 56 days before dry off to the end of lactation. Days of lactation was similar for the three groups (Control DIM = 320 d, Normal bST DIM = 331 d, Early bST Withdrawal = 325 d). Milk yield from week 9 to dry off was higher in cattle receiving Posilac (8526 kg) than Control (7868 kg). During the last two months of lactation milk production was similar (1203 kg, 1223 kg and 1039 kg for Control, Normal bST and Early bST withdrawal groups, respectively). Body weight gain from week 9 of lactation to dry off was similar between groups (98 kg, 80 kg and 93 kg for Control, Normal bST and Early bST withdrawal groups, respectively). Early withdrawal of bST did not improve weight gain during the last two months of lactation or during the dry period.

Key Words: Dairy Cattle, Somatotropin, Nutrition

1260 Yeast improved performance of Holstein cows receiving somatotropin when diets based on corn silage were fed. J. E. Wohlt*, T. Otero, and P. K. Zajac, Rutgers University, New Brunswick, NJ.

Forty multiparous Holstein cows were individually fed a corn silage:grain TMR and long hay (.9 kg/d) through wk 17 of lactation. Beginning 30 d prepartum through wk 17 of lactation the TMR of 20 cows was top dressed daily with 10 g of Biomate[®] Yeast Plus[®]. Other cows (n=20) served as controls. On d 63, cows within each group were further subdivided (n=10) into cows untreated and cows treated biweekly with Posilac[®]. Weeks 8 to 9 served as the baseline period and wk 10 to 17 served as the test period. Feeding yeast to cows receiving bST increased DMI (yeast x bST, P < 0.05). Persistency of milk yield was increased by feeding yeast (P < 0.10) and the use of bST (P < 0.10). Milk yields of bST treated cows fed yeast were above baseline throughout the test period. Milk fat and protein test and body weight and condition score were not affected. NJ Agric. Expt. Sta. No. K-06133-1-97.

	0 g/d yeast		10 g/d yeast	
	-bST	+bST	-bST	+bST
	Change from wk 8-9, kg/d			

Wk 10-17				
DMI	1.17	0.35	0.11	1.11
Milk	-1.16	-0.72	-0.88	1.23
3.5% FCM	-1.37	-1.98	-2.04	0.38

Key Words: Yeast Supplement, Bovine Somatotropin, Lactation Performance

1261 Dietary vitamin A affects the concentration of vitamin E associated with plasma lipoproteins in neonatal calves. B. N. Ametaj^{1*}, B. J. Nonnecke², T. A. Reinhardt², R. L. Horst², and S. T. Franklin³, ¹Iowa State University, Ames, ²USDA, ARS, NADC, Ames, IA, ³South Dakota State University, Brookings.

The practice of supplementing milk replacers fed to calves with high levels of vitamin A (VitA) has raised concerns regarding the effect of excess VitA on the bioavailability of vitamin E. Using a 4 X 2 factorial experiment, we evaluated the effects of four dietary levels of VitA (0, 1,700, 34,000, and 68,000 IU/d as retinyl acetate) and two forms of vitamin E (d- α -tocopherol and d- α -tocopherol acetate at 100/IU/d) on lipoprotein(Lp) associated α -tocopherol (α T) in plasma from milk replacer-fed calves from birth to 5wk of age). Plasma Lp fractions (VLDL, LDL, HDL and VHDL) were isolated and associated α T concentrations were determined. Amounts of α T associated with total Lp (tLp) and HDL, VHDL, LDL, and VLDL fractions were unaffected by the form of vitamin E fed to the calves. α T concentrations associated with tLp and HDL, VHDL, LDL, and VLDL fractions increased (P<.0001) with age and were maximal at wk 5. At birth, 50% of tLp-associated α T was in the VHDL fraction, with only 9% remaining in this fraction by 5 wk postpartum. The main carrier of α T from wk 1 to 5 was the HDL (65-74%) with LDL and VLDL transporting 15 and 3% of the α T, respectively. The amount of dietary VitA profoundly affected the concentration of Lp-associated α T. The tLp-associated α T concentrations were lower (P<.0001) in calves fed 34,000 and 68,000 IU/d of VitA (20.4 and 14.9 μ g/ml, respectively) than in control calves fed 0 IU/d of Vit A (27.6 μ g/ml) at 3wk postpartum. By 5wk postpartum, calves fed VitA at 1700 IU/d (NRC recommended daily requirement) also had lower (P<.0001) tLp-associated α T (41.7 μ g/ml) concentrations than control calves (52.4 μ g/ml). During this period, the amount of α T associated with HDL, VHDL, and LDL was similarly affected by dietary VitA, with lowest α T concentrations occurring in calves fed 68000 IU of VitA/d. At wk 1 postpartum; however, calves not supplemented with Vit A had the lowest α T concentrations in these fractions. In conclusion, the form of dietary vitamin E had no effect on concentration of α T present in tLp or its fractions suggesting the more stable and less costly form, α -tocopheryl acetate, be used. Because of the critical antioxidant role of vitamin E, the health-related consequences associated with the depression in Lp-associated α T concentrations in calves fed VitA at 34,000 and 68,000 IU/d must be investigated.

Key Words: Vitamin E, Vitamin A, Lipoproteins

1262 Influence of L-carnitine on growth and blood metabolic criteria of calves fed rations containing broiler litter. S. M. DeRouen^{1*}, J. M. Fernandez¹, L. D. Bunting¹, and S. A. Blum², ¹Louisiana State University Agricultural Center, Baton Rouge and Homer, ²Lonza, Inc., Fair Lawn, New Jersey.

Two feeding trials were conducted over 2 yr to determine the effect of L-carnitine when added to a broiler litter-corn ration for weaned beef calves. Sixty-six calves were equally allocated to six experimental paddocks by initial shrunk BW (mean BW=236 kg), breed type, and sex. The two treatment diets fed ad libitum, replicated over 3 paddocks per treatment, were: 1) 50% broiler litter, 50% corn ration (BL); and 2) 50% broiler litter, 50% corn ration plus 250 ppm of L-carnitine (BL+C). All calves were supplemented daily with 1.8 kg/hd of bermudagrass hay. Trial durations in yr 1 was 92 d and in yr 2 was 112 d. Jugular blood samples were collected on d 56 (yr 1) and d 64 (yr 2) and at the end of each trial. The statistical model included the effects of year, treatment, year X treatment, paddock within treatment, and residual error. Year and year X treatment were not significant for any response trait studied. Mean DMI of ration (7.09 vs 5.70 kg/d; P<.01) was greater and ADG (.96 vs .88 kg; P=.15) tended to be greater for BL+C-fed calves compared with calves fed BL. Gain:feed ratio (.136 vs .154; P<.01) was lower for BL+C-fed calves. Plasma ammonia N, urea N, and glucose concentrations (P>.12) were not affected by dietary ration. Results from this study indicate that calves fed broiler litter-corn diet plus L-carnitine responded with 24% higher DMI of ration and 9% higher daily gains.

Key Words: Broiler litter, Carnitine, Calves

1263 Endocrin and metabolic changes on early weaned calves; effect of different diets. H. T. Fernandez*, H. E. Laborde, and L. M. Fernandez, *CERZOS/Universidad Nacional del Sur*.

The objective of the experiment was to analyze the effect of different diets upon the concentration of glucose (G), insulin (I), and their possible effect on growth. Eighteen four-day old calves were kept in individual pens in a closed barn with a split plot in time design. The experiment included a period of 60 days (M) in which milk substitute (MS) was supplied, and another period of 30 days (NM) without MS. The diets with *ad libitum* supply were: L=MS until 60 days and then commercial concentrate diet (CC) + 500g of grinded hay (GH); LC=MS + CC until 60 days and then CC + 500g of GH; LH=MS + GH until 60 days and then GH + 200g of CC. Weekly G and I in blood, and average daily gain (ADG) were estimated.

Item	M/	M/	M/	M/	M/	NM/	NM/	NM/	NM/	NM/
Item	L	LC	LH	ES	Sig	L	LC	LH	ES	Sig
ADG (Kg/d)	0.17a	0.23a	0.23a	0.02	ns	0.97a	1.05a	0.66b	0.05	**
G (g/l)	0.77a	0.80a	0.82a	0.02	ns	0.78a	0.77a	0.69a	0.02	ns
I (µU/ml)	3.52a	3.66a	3.78a	0.09	ns	4.14a	4.30a	3.51b	0.14	**

In the same row, for each period, different letters indicate significant differences (P<0.01). In the period NM, no interaction was found among none of the factors, for ADG and I. The highest ADG for the L diet and LC diet, with a higher proportion of CC, might be related to the highest levels of I registered in the calves fed those diets.

Key Words: Glucose, Insulin, Growth

1264 Effect of conjugated linoleic acid on calves fed calf milk replacer. M. A. Fowler*, R. M. DeGregorio, B. L. Miller, T. E. Johnson, and H. B. Perry, *Land O'Lakes, Inc., Fort Dodge, Iowa*.

A calf performance trial was conducted with 56 Holstein bull calves (43.9 kg, average initial weight) to evaluate the feeding of conjugated linoleic acid (CLA) to calves receiving a medicated calf milk replacer (CMR). Treatments consisted of all-milk high fat (20%) CMR containing two levels of CLA (0 or 2.3 grams per calf daily). Calves were fed CMR twice daily. Calves were weighed weekly with CMR consumption and subjective fecal scores recorded daily. Data analyzed included total calf weight gain, CMR consumption, feed conversion, fecal score and scour days. All data are mean values for a 28-day period.

Item	Control	CLA	C.V. %
Weight gain, kg.	15.40 ^a	14.25 ^b	13.03
CMR Consumption, kg.	21.72	21.73	1.62
Feed Conversion, kg. feed/kg. gain	1.44 ^b	1.55 ^a	13.27
Average Fecal Score	1.08	1.09	10.41
Scour Days	1.83	2.11	133.76

^{a,b} Means differ (P<.05) Control calves had significantly greater calf weight gain (P<.05) and feed conversion (P<.05) than calves receiving the conjugated linoleic acid (CLA) treatment. No differences in CMR consumption, average fecal score and scour days were observed among treatments (P>.05).

Key Words: Conjugated Linoleic Acid, Calves, Milk Replacer

1265 Dairy calf starter rations supplemented with spray dried plasma. J. A. Godfredson-Kisic and S. R. Goodall*, *DuCoa, Highland, IL*.

Our objective was to examine the effects of spray dried plasma (SDP) in the starter rations of dairy calves. Eighty Holstein calves, from a commercial dairy farm in Northern Colorado, were weaned between 56 and 69 days of age. Half (20 males, 20 females) were assigned to starter rations containing 6% SDP (DuCoa 780). The other half were fed control diets containing a vegetable protein base without plasma. Protein levels of both diets were approximately 17.5%. Water and rations were offered *ad libitum* for the entire 32-day trial. Calves were weighed each week, and feed intake was monitored twice weekly. Health problems were incurred the first week post-weaning due to severe weather conditions. Calves were treated and resumed normal gains and feed intakes by day 14. There were no diet effects on overall average daily gains. Dietary plasma did significantly improve gain/feed ratios on days 14, 28 and overall for the period of day 7-32. There was not a sex affect on gain, feed intake and feed efficiency. Overall, plasma added to the starter diets of weaned dairy calves appears to have a positive effect on feed efficiency.

	ITEM	CONTROL DIET	SDP DIET	P-value
ADG (g/day)	7-14 days	412 ± 97.6	605 ± 94.7	0.161
	14-21 days	1156 ± 101	816 ± 92.0	0.016
	21-28 days	1078 ± 86.2	1156 ± 81.6	0.514
	28-32 days	603 ± 105	605 ± 62.2	0.986
	7-32 days	812 ± 45.1	796 ± 51.7	0.810
Gain / Feed	7-14 days	0.174 ± 0.04	0.325 ± 0.05	0.022
	14-21 days	0.432 ± 0.04	0.349 ± 0.04	0.133
	21-28 days	0.300 ± 0.02	0.399 ± 0.03	0.010
	28-32 days	0.151 ± 0.03	0.192 ± 0.02	0.226
	7-32 days	0.264 ± 0.02	0.316 ± 0.02	0.052

Key Words: Calves, Plasma, Diet

1266 Effect of adding AGRADO™ to the receiving ration on morbidity and performance of calves new to the feedlot environment. E. B. Kegley*¹, D. H. Hellwig¹, D. R. Gill², F. N. Owens², and W. A. Samuels³, ¹University of Arkansas, Fayetteville, ²Oklahoma State University, Stillwater, and ³Solutia Inc., St. Louis, MO.

Ninety six mixed breed heifer calves (206 ± 1.4 kg initial BW) were used to determine the effect of adding AGRADO™, a compound produced by Solutia, St. Louis, MO., to the receiving ration on growth, feed efficiency, and incidence of morbidity. Heifers were purchased at sale barns by an order buyer and delivered as one group to the research facility in Fayetteville. Heifers were allocated randomly within eight weight blocks to treatment, with six heifers in each of 16 pens for a total of 48 heifers per treatment. All heifers were fed a totally mixed ration containing 30% cottonseed hulls, 53% cracked corn, and 11% soybean meal for 42 days. Treatments consisted of 0 or 150 mg AGRADO™/kg of diet. Heifers were observed daily for signs of morbidity. Fewer of the heifers fed supplemental AGRADO™ became sick (73 vs. 83%, P < .05). Therefore, medication costs were lower for heifers fed supplemental AGRADO™ (\$5.75 vs. \$8.63 per pen, P < .04). No significant effects of supplementation were detected on the number of calves becoming sick a second time or on the day that first illness occurred. Average daily gain, daily feed intake, and gain/feed for the 42 d study were not affected by supplemental AGRADO™ (P > .10). While supplemental AGRADO™ did not significantly improve rate or efficiency of gain, it decreased the incidence of morbidity, and lowered medication costs. Addition of AGRADO™ to a receiving ration for calves appears to reduce respiratory disease problems.

Key Words: Beef Cattle, Respiratory Disease, Feedlot

1267 **Effet of supplementing latobacillus in the diet of bucket fed alves on feed intake and weaning weight.** U. M. López, V. V. Balderas, I. Tovar-Luna*, J. J. Jaimes, F. R. Castro, and H. Suárez, *Universidad Autonoma Chapingo. URUZA, Bermejillo, México.*

The objective of this study was to evaluate the effect of three commercial sources of Lactobacillus for gastrointestinal supplementation in bucket fed calves. Thirty female Holstein calves (birth weight = 37.15 kg) were randomly assigned to one of four treatments: Bovine Paste (BP, Loveland Industries, Inc), Probios (PR, Pioneer Hi-Bread Industry, Inc), Bio-Calf (BC, CEMPOAL, PROSAN, S.A. de C.V.), and a control (C). Lactobacillus concentration in the product was 7 to 8 million colony forming units per g. Dosage criteria was according to that of supplier recommendation. Bovine Paste and Probios were supplied at birth and weaning, while Bio-Calf was administered daily. Calves were individually penned and had free access to alfalfa hay (18% CP) and concentrate (18% CP) and clean water over the entire experimental period. Calves fed milk replacer twice a day: 2L at 800 h and 1600 h. Weaning weights ($P < .3$) and ADG ($P < .3$) were 65.0, 62.4, 66.0 and 64.2 1 2.4 kg, and .46, .42, .48 and .45 1 .04 kg, for BP, PR, BC, and C treated calves, respectively. Days after birth to first consuming alfalfa hay ($P < .03$) were 17.4, 20.4 14.0, and 26.0 1 3.3 d, and for concentrate ($P < .03$) were 15.8, 22.7, 9.0 and 17.3 1 3.2 d, respectively. Dry matter intake per animal per day was similar ($P > .05$) among treatments the last ten day of the experimental period. Calves fed BC seemed to be more vigorous than the others. Results indicate that supplementing BC to bucket fed calves stimulate them to consume solid food earlier resulting in slightly heavier weaning weight.

1268 **Supply of hydrogenated fat in dairy calf starter ratio.** J. Maiztegui, M. Gallardo, G. Romano*, S. Valtorta, and R. Rodríguez, *FAVE-UNL, Argentina.*

The objective was to evaluate the effect of hydrogenated fat from fish oil in dairy calf weight gain. Twenty Holstein friesian bull calves approximately 3 d of age and averaging 37.5 kg were allocated by weight to two groups. Calves received 0.44 kg of a milk replacer per day for 42 d, containing 12% fat and 21% protein. They were fed twice a day. Treatments were commercial calf starter (control, CG) and commercial calf starter plus 2% hydrogenated fat (FG). Starter contained 18.2% CP, 22.7% NDF, minerals and vitamins and was fed free choice. Calves were held in individual steel pens 1.2 x 1.5 m inside. Water was fed 2 hours after milk replacer. Milk replacer, water and starter intake was recorded daily. Body weight and blood samples were taken at 0, 14, 28 and 42 d of treatment. Blood samples were assayed for BUN, glucose and triglycerides. Data were statistically analyzed by GLM procedure of SAS. The FG calves had a higher (7.9%) ADG than CG. The feed efficiency was highest for FG. Blood parameters were similar for both groups. It can be concluded that supplementation with hydrogenated fat would increase the performance of bull calves.

Measurement	CG	FG	P <
DMI (kg of starter)	0.718	0.615	0.241
Water (l)	1.80	1.53	0.065
ADG kg	0.527	0.569	0.549
BW (42 d)	59.6	61.4	0.881
Efficiency ADG/DMI	0.733	0.925	0.112
BUN mg/dl	20.0	21.2	0.784
Glucose mg/dl	66.6	65.5	0.812
Triglycerides mg/dl	388.5	421.2	0.606

Key Words: Calves, Fat, Starter

1269 **Weaning age and feeding strategy on calf performance.** A. J. Pordomingo*, N. A. Juan, and R. Jouli, *EEA INTA Ing. Agr. Guillermo Covas, Argentina.*

To study the effects of feeding after weaning and age at weaning on calf average daily gain (ADG), and weight after 148 d of trial (LW148d), two feeding strategies and three age groups at early-weaning time were combined. Feeding strategies imposed on early-weaned (EW) calves were: T15 = supplementation on pasture for 15 d, and T45 = supplementation for 45 d. A third treatment, incorporated as reference, was: CNTRL = weaning at 6 months of age for the oldest group. Three age groups were: AGE<80d = calves 71±2.8d old at weaning, AGE80-100d = calves 91±1.6d old, and AGE>100d = calves 111±2.2d old. Weaned calves were pen-fed for 12 d (50% CP-energy concentrate + 50% alfalfa hay) and grazed on a mixed alfalfa-bromus pasture for 134 d. CNTRL calves received no supplement. Older calves at early-weaning time were heaviest ($p < .05$) at the end of trial. The youngest EW calves had the lowest ADG, different from the other two age groups ($p < .05$). No differences were detected ($p = .58$) between age groups in ADG for CNTRL. Lower ADG was significant ($p < .05$) for AGE<80d in T15 and T45. Results indicate that 70d-old EW calves would be most affected under these feeding strategies, especially in T15. The EW calves had lower performance than suckled calves.

	T15	T45	CNTRL
LW148d, kg			
AGE>100d	186±6.5 ^a	190±6.2 ^{a,b}	205±6.8 ^{b,c}
AGE80-100d	164±5.8 ^a	172±6.0 ^{a,b}	180±2.0 ^{b,c}
AGE<80d	134±7.5 ^a	147±5.6 ^a	178±7.5 ^c
ADG, g/d			
AGE>100d	520±24 ^{a,f}	501±22 ^{a,f}	618±25 ^{c,f}
AGE80-100d	480±22 ^{a,f}	506±23 ^{a,f}	613±22 ^{c,f}
AGE<80d	395±30 ^{a,g}	449±22 ^{b,f}	659±30 ^{c,f}

Row means with consecutive superscripts ^{a,b,c} differ ($p < .1$).

Row means with non-consecutive superscripts ^{a,b,c} differ ($p < .05$).

Column means for ADG with different superscript ^{f,g} differ ($p < .05$).

Key Words: Early-weaning, Calf Supplementation, Grazing Calves

1270 **Effect of roughage source and concentrate supplementation period on performance of early-weaned calves.** A. J. Pordomingo, N. A. Juan, and R. Jouli, ¹EEA INTA "Guillermo Covas", *Anguil, La Pampa, Argentina.*

The objective of this work was to study the effects of local roughage sources in 50% roughage diets, age at early weaning and length of the supplementary period on pasture on performance of early-weaned calves. Thirty-two medium-frame Angus calves were divided in two age groups (G1: age = 65 d, 71 kg; G2: age = 77 d; 92 kg). Each group was allocated to four diets: T1 = 50% of the diet as 18% CP-energy concentrate +50% alfalfa hay, T2 = 50%concentrate+50% oats hay, T3 = 50%concentrate+50% oats silage, T4 = same as T1 during 12 days, 20 days of 1.6% of LW as concentrate daily + pasture, 30 days 100% pasture. Treatments 1, 2, and 3 were pen-fed for 62 days. On day 63, animals from T1, T2 and T3 were transferred to the same pasture of T4 for 68 more days and received no complementary feeds. No differences among diets were detected ($p > .50$) in final LW within group (130 day trial; G1: 130, 132, 132 and 115 kg, G2: 153, 155, 159 and 158 kg, for T1, T2, T3 and T4, respectively). Average daily gain (ADG) was greater ($p < .05$) in G2 compared to G1. No differences were detected between treatments within groups in ADG(G1 [$p = .17$]: 585, 615, 658 and 490 g/d, for T1, T2, T3 and T4, respectively; G2 [$p = .87$]: 660, 648, 693 and 727 g/d). However, interruption of supplementation in T4 on day 32 affected adversely performance in G1 during the following 30 days. Rates of ADG for the first 62 day period were: 653, 702, 657 and 617 g/d for T1, T2, T3 and T4 in G2 ($p > .1$), and 585, 629, 686 and 355 g/ in G1 ($p < .001$). T4 partially compensated in the remaining of the trial. Results indicate that performance of weaned calves fed diets like this trial would be similar. Shortening supplementation period to 32 d after weaning would not affect performance of calves weaned with more than 70 days of age and more than 90 kg, compared with supplemented ones. However, if calves are younger and lighter, supplementation during at least additional 30 days would be necessary.

Key Words: Early Weaning, Calf Supplementation, Roughages

1271 Influence of urea, fish solubles, fish meal or feather meal and L-carnitine in liquid supplement for grazing calves. T. W. White, J. M. Fernandez, L. R. Gentry, P. T. DeRouen, G. T. Gentry, and G. K. Armes*, *Louisiana State University Agricultural Center, Baton Rouge.*

Two experiments were conducted for 84-d with weanling calves grazing mature forage to evaluate supplements containing urea (U), fish solubles (FS), fish meal (FM)(Sea-LacTM), or feather meal (FE) with or without L-carnitine (Lonza, Inc.). Treatments in a 4 × 2 arrangement were 3% U, 33% FS, 16% FM, or 12% FE added to a U-molasses mixture (PM Ag, Inc.) to make 25% CP supplements each with L-carnitine to provide 0 or 1 g·hd⁻¹·d⁻¹. Calves were assigned (4) to each of three pastures in Exp. 1 (BW = 199 kg) and (5) to each of two pastures in Exp. 2 (BW = 175 kg) on each supplement-carnitine combination. Blood samples were collected on d 42 of each experiment. Differences (P < .05) were detected in ADG (g) for FM, FE, U and FS, 407, 252, 156, and 17 in Exp. 1 and 356, 278, 153, and -3 in Exp. 2, respectively. Supplement intake generally following this pattern was lowest (P < .05) for FS in both experiments and highest (P < .05) for FM in Exp. 1. Carnitine reduced (P < .05) ADG in Exp. 2, and interactions (P < .05) on protein source resulted in decreased ADG for all protein sources except FS in Exp. 1 and U in Exp. 2. Plasma ammonia and urea levels were generally highest for U and FS in Exp. 1 but lowest (P < .05) for FS in Exp. 2. Carnitine reduces (P < .05) plasma urea in Exp. 2. These data suggest the benefit of including FM and FE in liquid supplement for grazing calves. Additional research is warranted on carnitine in ruminant nutrition.

Key Words: Calves, Protein Supplements, L-Carnitine

1272 Influence of L-carnitine on growth rate and blood metabolites of weanling calves. T. W. White, J. M. Fernandez*, G. K. Armes, and P. T. DeRouen, *Louisiana State University Agricultural Center, Baton Rouge.*

An experiment was conducted for 60 d to study the effect of feeding L-carnitine (Lonza, Inc) on performance and blood metabolites of calves grazing mature forage with access to grass hay. Treatments were 0, .5, 1 or 2 g of L-carnitine fed in a mixture of 1695 g corn, 200 g soybean meal, 60 g urea and 88 g of minerals per calf daily. Calves (84 with BW = 188 Kg) were randomly allotted so that there were 7 calves in each of three pastures on each treatment. Weights were taken 16 h after removing calves from feed and water. Blood was collected via jugular venipuncture 2 h after feeding on d 27 and 59. All levels of L-carnitine improved (P < .01) ADG when compared with no carnitine (375, 465, 450 and 494 g/d for the respective levels). Plasma ammonia, urea and glucose concentration changes were not consistent with carnitine intake on d 27 and were generally higher on d 27 than on d 59. Carnitine reduced (P < .05) plasma urea concentration when compared with no carnitine on d 59. Plasma glucose concentration was reduced (P < .05) by 1 g but increased (P < .05) by 2 g of carnitine on d 59. Albumin concentrations were similar for all carnitine intake levels and at both samplings. Additional research is needed to confirm these data.

Key Words: Calves, L-Carnitine

1273 The response of additional dietary protein fed to prepubertal heifers on feed efficiency and growth. A. J. Heinrichs* and B. P. Lammers, *The Pennsylvania State University.*

This study tests the hypothesis that increased dietary protein levels above NRC recommendations could enhance performance in Holstein heifers. Forty-five Holstein heifers were assigned to either a low (12%), medium (14%), or high (16%) level of dietary protein with an energy density of 2.55 Mcal ME/kg. All diets were balanced for 32% soluble protein and the same ratios of NDF to NSC. Heifers were individually fed in Calan feeding doors and began the treatment period at 200 kg of body weight (BW) and 197 d of age. During the 3 week adaptation period and 140 day treatment period, all heifers were fed for a daily DMI of 2.45% of BW. BW was monitored for two consecutive days each week and was used to adjust the DM offered on a weekly basis. The high vs low protein diet increased feed efficiency 6.3% which resulted in larger heifers that were subsequently fed 2.6% more over the course of the trial. The increased feed efficiency and DMI increased ADG 9.5% for the high vs low level of dietary protein. For the high vs low level of dietary protein, hip width, hip height, and heart girth growth was increased 13.3, 15.6, and 12.3%, respectively.

Item	Level of Dietary Protein		
	Low	Medium	High
FE (feed/gain)	6.38 ^a	6.28 ^{a,b}	5.98 ^b
DMI (g/d)	6420 ^b	6460 ^b	6590 ^a
Rate of gain (g/d)	1010 ^b	1030 ^b	1106 ^a
Hip width growth (cm/d)	0.060 ^b	0.065 ^{a,b}	0.068 ^a
Hip height growth (cm/d)	0.109 ^b	0.116 ^{a,b}	0.126 ^a
Heart girth growth (cm/d)	0.204 ^b	0.212 ^{a,b}	0.229 ^a

^{a,b} Means in rows with different superscripts differ (p < 0.05).

Key Words: Heifers, Protein, Growth

1274 Effect of varying dietary chromium supplementation on growth and humoral patterns of growing calves. J. A. Jackson* and D. S. Trammell, *University of Kentucky, Lexington.*

Twenty four Holstein steer calves (98 kg BW) were randomly assigned to treatments of 1) basal diet, 2) basal diet with .4 ppm dietary supplementation with Cr, 3) basal diet with .8 ppm dietary supplementation with Cr and 4) basal diet with 1.2 ppm dietary supplementation with Cr. Chromium was supplemented as chromium picolinate. All calves were fed the control diet during a 1 wk preliminary period, and the treatment diets were fed for 9 wk. Body weights were recorded and jugular blood sampled at 3 hr post-feeding on wk 0, 3, 6, and 9. The basal diet contained 9% whole cottonseed to provide 5.6% dietary fat. Feed intakes (as-fed) were 5.0, 5.7, 5.4, and 5.1 kg/d (NS) for the 0, .4, .8, and 1.2 ppm dietary treatment groups. A quadratic response (P = .07) was noted for ADG. Gains averaged 1.39, 1.62, 1.47, and 1.37 kg/d for the 0, .4, .8, and 1.2 ppm dietary treatment groups. Plasma triglycerides were 35.5, 36.2, 34.0, and 35.3 mg/dl (NS) for the 0, .4, .8, and 1.2 dietary treatment groups. Diets supplemented with .4 and .8 ppm Cr as chromium picolinate were equally effective in supporting growth in growing Holstein calves.

Key Words: Chromium, Calves

1275 Blood and liver uptake of various organic trace minerals in dairy heifers: the relationship of cobalt to copper, zinc and manganese. R. T. Winn¹ and L. K. Schlatter*², ¹Winn Veterinary Clinic, Big Sandy, TX ²Kemin Industries, Inc., Des Moines, IA.

Different organic sources of the trace minerals zinc, copper, manganese and cobalt were fed to dairy heifers over a six week period along with an unsupplemented control. The trace minerals were either complexed with an amino acid, glucoheptonate, or propionate. In addition, supplemental cobalt propionate was fed at 0.72, 1.44, 3.60 and 7.20 ppm with the other three propionate salts, and at 3.6 ppm with the other complexes. Blood was collected weekly. Cobalt levels in the blood, and manganese, copper and zinc levels in the serum were determined for each sample. Liver copper, zinc and manganese levels were established at the beginning of the trial and at the end. Cobalt uptake into the serum was linear over all doses through three weeks. Continued supplementation of cobalt past three weeks maintained the blood cobalt level observed at the end of three weeks. Cobalt propionate levels in the blood were numerically higher than the cobalt glucoheptonate levels at similar doses. Zinc supplementation elevated serum zinc levels within one week. Zinc propionate elevated serum zinc levels greater than did zinc methionine ($P < 0.001$). However, liver zinc levels fell throughout the trial, indicating that the level of supplementation (50 ppm) may not have been high enough for the animals to establish zinc homeostasis. No relationship was observed between zinc and cobalt. Manganese levels were initially elevated by supplementation. However, after two weeks, no difference could be observed between control and supplementation. Manganese indicated no relationship to cobalt levels. Copper levels in both serum and liver were enhanced by supplementation. However, elevated cobalt levels appeared to depress copper in both serum and liver. Copper propionate elevated serum copper levels greater than did copper lysine ($P < 0.0001$).

Key Words: Trace Minerals, Bioavailability, Dose Response

1276 Milk production and reproductive performance of dairy cows fed low or normal phosphorus diets. Z. Wu and L. D. Satter, *US Dairy Forage Research Center, USDA-ARS, and Dairy Science Department, University of Wisconsin, Madison.*

The objective was to determine if P supplementation of a typical lactation diet is necessary. At calving (September to October) 48 Holsteins were assigned randomly to a low or normal P diet. Cows were fed a TMR (corn silage, alfalfa silage, high moisture ear corn, and roasted soybeans) in free stalls until the middle of May. Pasture provided the forage until the end of August, by which time all of the cows were dried off. Supplemental mixes were fed during grazing (7.0 kg/d, DM) to provide approximately 40% of total feed intake. The P content was .35 or .45% of the TMR (DM basis), and .35 or .65% of the supplements for the low and normal P diets. Pasture herbage averaged .30% P. Supplemental P was fed to achieve the higher P amounts. Milk yield averaged for the entire lactation did not differ between the groups. Milk protein concentration was reduced in the low P group; however, protein yield did not differ. Blood serum P concentrations were within normal ranges for both groups. Cows on low P were detected in estrus 8.3 d later than those on normal P, but pregnancy rates were not different. Reducing dietary P from .45 to .35% for a complete lactation did not impair milk yield or reproductive performance. Inclusion of a P supplement in the diet was without apparent benefit, except for possibly a small increase in milk protein percentage.

Item	.35% P	.45% P	SEM	P
DMI, kg/d ¹	20.7	20.4
Milk, kg/d	31.7	29.5	1.1	.16
Milk fat, %	3.41	3.61	.09	.12
Milk protein, %	3.05	3.17	.04	.02
Serum P, mg/dl	6.0	6.7	.1	.01
Day to estrus	51.3	42.5	3.5	.09
Pregnancy rate, %				
Before 120 DIM	50.0	45.8
Entire lactation	87.5	79.2

¹Measured during confinement feeding.

Key Words: Dairy Cows, Phosphorus Requirement, Milk Production

1277 Effect of Anion BoosterTM on intake, acid-base status and calcium metabolism of dairy cows. J. G. Giesy^{1*}, W. K. Sanchez¹, B. I. Swanson¹, M. A. Guy¹, and R. R. Stuhr², ¹University of Idaho, Moscow and ²Stuhr Enterprises, Inc.

The objective of this study was to evaluate the effect of Anion Booster (AB) on dry matter intake, acid-base status and calcium (Ca) metabolism in the dairy cow. Two replicates of a 3 × 3 Latin square design with successive 14 d periods were used. Six Holstein dry cows were blocked by lactation number and status. Treatment diets were fed as a TMR consisting of concentrate mixes with no anionic salts (control; C), traditional anionic salts (AS) or AB added to a forage mix consisting of alfalfa hay, alfalfa silage and wheat straw. AB and anionic salt treatments were formulated for equal dietary cation-anion difference (DCAD). Intakes were recorded from d 8 to 14 of each period. Blood and urine samples were collected 2 h following feeding on d 14 of each period. Blood and urine samples were analyzed for pH and blood also was analyzed for ionized Ca (iCa), bicarbonate (HCO₃⁻) and pH. Pre-planned contrasts compared the C diet to AS and C to AB. Dry matter intake (DMI) for cows fed C (14.8 kg/d) was not different than for cows fed AS (12.7 kg/d) or AB (15.8 kg/d). Blood and urinary pH were lower ($P < 0.01$) for cows fed AB than C. Cows fed AS had lower ($P < 0.01$) urinary pH and tended to have lower ($P < 0.1$) blood pH than cows fed C. AB and AS caused a reduction ($P < 0.05$) in blood HCO₃⁻ when compared to cows fed C. Changes in acid-base status stimulated changes in Ca metabolism as blood iCa was significantly ($P < 0.01$) higher in cows fed AB (4.98 mg/dl) and AS (4.95 mg/dl) than C (4.77 mg/dl). AB showed similar ability to alter acid-base status and elevate blood iCa as AS. Results of this study indicate that Anion Booster has potential use in transition rations to reduce metabolic disorders through its ability to alter Ca metabolism while maintaining DMI.

1278 The effects of supplementing different levels of phosphorus and copper in beef finishing diets. L. A. Hurley*, T. L. Stanton, and D. Schutz, *Colorado State University, Fort Collins.*

Two hundred eighty-four steers calves (mean initial body wt. = 264.7 kg) were used in a 2 × 2 factorial design to evaluate levels of phosphorus and copper on 170 day growth performance and carcass characteristics. Steers were randomized by breed, blocked by weight, and assigned to one of four treatment groups; each group consisting of six pens of 11 or 12 steers each, for an average of 71 steers per treatment group. Steers were fed a finishing ration consisting of 87.7% whole corn, 3.4% alfalfa, 3.4% straw, and 5.7% supplement. The four treatments were: 1) High P/High Cu (.35% and 25 ppm, respectively), 2) High P/Low Cu (.35% and 10 ppm, respectively), 3) Low P/High Cu (.21% and 25 ppm, respectively), and 4) Low P/Low Cu (.21% and 10 ppm, respectively). There were no significant differences found for total intake (8.08, 8.85, 8.97, and 8.79 + .59 (kg/hd/d + SEM)), ADG (1.63, 1.72, 1.69, and 1.72 + .18 kg) and feed efficiency (gain/feed) (.18, .18, .17, .18 + .08) for the High P/High Cu, High P/Low Cu, Low P/High Cu, and Low P/Low Cu, respectively. No significant differences were found between supplement groups for hot carcass weight (335, 330, 325, and 333 + 7.6 kg), yield grade (2.99, 2.86, 3.01, 2.82, + .15) marbling score (254, 245, 247, and 243 + 1.14), and ribeye area (85.92, 85.5, 83.03, 85.55 + 1.87 cm²H) for the High P/High Cu, High P/Low Cu, Low P/High Cu, and Low P/Low Cu, respectively. Unshrunk dressing percent differed ($P < .05$) for High P/High Cu vs. Low P/High Cu (60.69 vs. 59.74 + .30%), respectively). Based on this data, phosphorus supplementation and copper inclusion above 10 ppm provided no additional growth enhancement.

Key Words: Phosphorus, Growth Performance, Carcass Characteristics

1279 Utilization of phosphorus by Holstein steers fed duckweed (*Lemna minor*) grown on dairy wastewater. S. O'Bryan*, T. F. Brown, and R. D. Wittie, *Tarleton State University, Stephenville, TX.*

Six Holstein steers (118 kg BW) were fed two diets (DW and Control) in a crossover treatment design to examine nitrogen and phosphorus utilization. In the DW diet, sun-dried duckweed was substituted for a portion (25%) of the soybean meal in the control diet to make two diets isonitrogenous. Since duckweed was high in phosphorus content (1.61%DM basis), the control diet was supplemented with monocalcium phosphate to make both diets isophosphoric. The duckweed used in this trial was grown in artificial wetland cells supplied with animal wastewater from a commercial dairy farm. All calves were fed 3.89kg of DM/day. The diets contained 12.8%CP, .66% calcium, and .42% phosphorus and were balanced for other minerals according to NRC recommendations. Percentage of phosphorus digested, absolute retention (g/d) and percentage of phosphorus retained were greater ($P < .05$, $P < .01$ and $P < .05$ respectively) for DW calves than for control calves. Means for these three variables were 63.89%, 9.03g/d and 55.41% for DW calves compared to 56.77%, 7.41g/d and 46.58% for control calves. Nitrogen in both diets was used with equal efficiency for all variables measured. It appears that nitrogen and phosphorus in duckweed are used with at least the same degree of efficiency as nitrogen and phosphorus from conventional feedstuffs.

Key Words: Wastewater, Duckweed, Phosphorus

1280 Feeding copper lysine and copper sulfate to cattle. P. A. Rabiansky, L. R. McDowell*, J. Velasquez-Pereira, N. S. Wilkinson, D. B. Bates, A. B. Johnson, T. R. Batra, and E. Salgado-Madriz, *University of Florida, Gainesville, FL.*

The effects of feeding different sources and quantities of Cu to cattle was evaluated in a 211 d experiment. Forty crossbred predominantly Brahman \times Hereford heifers averaging 13.5 mo of age and 301.4 kg were initially depleted of Cu. The depletion diet was fed for 70 d and consisted of low Cu and high antagonist minerals, Fe, S, and Mo at 1000 ppm, .5%, and 5 ppm, respectively. On d 71, animals continued to receive the antagonistic minerals and were allotted equally to five different Cu treatments: 1) Control—no additional Cu source; 2) Copper Sulfate (CuSO₄)—8 ppm; 3) Copper Sulfate (CuSO₄)—16 ppm; 4) Cu Lysine—8 ppm; and 5) Cu Lysine—16 ppm. When no notable change in liver Cu was observed, d 169, a second diet was formulated. The animals were fed the same Cu treatments but S and Mo were removed and Fe was lowered to 50 ppm. This diet was then fed for the final 42 d of the experiment. In addition to performance, the parameters measured were liver and serum Cu, Fe, and Zn, plasma ceruloplasmin, hemoglobin, superoxide dismutase (SOD) activity of neutrophils and lymphocytes, and a cell mediated immune response (phytohemagglutinin-P, PHA). Animals in this study had increased growth over time ($P < .05$), but there were no treatment differences for growth and average daily gain. Liver and serum Cu concentrations were not greatly influenced by different supplemental Cu sources. However, Cu lysine (16 ppm) more effectively increased ($P < .05$) liver and plasma levels in animals that were extremely deficient in Cu. Iron concentrations decreased ($P < .05$) over time, but there was no difference ($P > .10$) in liver and serum Fe and Zn among treatments. Ceruloplasmin and hemoglobin concentrations were significant ($P < .05$) over time but not among treatments ($P > .10$). The SOD activity over time was not different ($P > .10$) in neutrophils, but lymphocytes increased over time ($P < .05$). For the PHA immune response test, there was no difference in time or time by treatment ($P > .10$). This data suggest that all Cu sources were available, but Cu lysine at 16 ppm was most beneficial for animals with low Cu status.

Key Words: Copper Sulfate, Copper Lysine, Cattle

1281 Effect of supplementation of cholecalciferol and phosphorus on retention of phosphorus in sheep. I. Mejia-Haro* and D. R. Brink, *University of Nebraska-Lincoln.*

An experiment was conducted to study the effects of supplementation of cholecalciferol (vit. D) and P on P retention in sheep fed a maintenance diet, and explore techniques to predict P status in ruminants. Forty-two lambs (43 kg) were assigned randomly to 6 treatments, consisting of supplementation of 0, 1, or 2 g of P without (T1, T3, and T5) or with the addition of vit. D (T2, T4, and T6, respectively). Before assignment of treatments lambs were fed a P depletion diet for 8 wk.; and during the experimental period (8 wk) they were fed individually the same amount. Fecal and urine samples were totally collected during the last 3 d of the experiment. Blood serum samples were collected at the beginning and at the end of the experiment. Rib bones were taken after the sacrifice of lambs of T2 and T6. Feed samples were collected weekly. In all the samples P concentration was determined by spectrophotometry. P retained in the body was greater ($P = .0069$) in lambs supplemented with P (T3, 53; T4, 44; T5, 36; and T6, 47 mg/W^{.75}H/d) than in lambs in T1(1.8 mg/W^{.75}H/d). Supplementation of vit. D did not affect the P concentration of any sample. No differences ($P > .05$) were found in P retention in lambs supplemented with 1 or 2 g P/d. However, the total P excreted (fecal + urinary P) was higher ($P = .0001$) in lambs in T5 and T6 (234, and 236 mg /W^{.75}H/d) than in lambs in T3 and T4 (160 and 174 mg/W^{.75}H/d). No differences ($P > .05$) were found in the concentration of P in bone, in different bases (fresh, dry, ash, and mg/cm³H). Differences in the concentrations of P in blood serum were found only in T5, which was higher ($P < .05$) than T1, T2, and T6. The excretion of P in urine (mg/W^{.75}H/d) was higher ($P = .044$) in T6 than in T1, T2, and T3. The amount of P retained in the body increased by supplementing either 1 or 2 g of P/d. Supplementation of vit. D had no effect in P retention. Regression analysis indicates that P intake may be predicted through the total P excreted ($P = .0001$) and P in urine ($P = .1345$) reported in mg/W^{.75}H/d.

Key Words: Phosphorus, Cholecalciferol, Sheep

1282 A comparison of the ruminal alkalizing potential of brucite (magnesium hydroxide) and sodium bicarbonate for feedlot cattle. M. F. Montano^{1,2,3*}, F. Calderon¹, F. Castrejon³, J. D. Garza³, F. Perez-Gil³, C. Vasquez³, and R. A. Zinn^{1,2}, ¹*Instituto de Ciencias Veterinarias-UABC, Mexicali (México)*, ²*University of California, El Centro*, ³*Facultad de Medicina Veterinaria y Zootecnia-UNAM, México, D. F. (México).*

Four Holstein steers (320 kg) with ruminal cannulas were used in a 4 \times 4 Latin square experiment to evaluate the effect of supplemental brucite (BRU, a naturally occurring source of magnesium hydroxide) and sodium bicarbonate (BICARB) on ruminal characteristics of steers fed a high-energy finishing diet. The basal diet contained 70% steam-flaked wheat, 4% yellow grease and 12% forage. On the day of collection, a 500-g challenge of glucose was introduced into the rumen via the ruminal cannula 1 h after the morning feeding. Buffers increased ruminal pH (6.3 vs 6.1; $P < .05$) 1 h after feeding. Buffers did not influence ($P > .10$) ruminal pH following the glucose challenge. Supplemental BICARB decreased ($P < .05$) ruminal L-lactic acid vs control. Ruminal fluid osmolality was decreased ($P < .05$) by 1% BRU and 1% BICARB supplementation. Ruminal fluid osmolality was higher ($P < .05$) between 2 and 5 h after feeding for steers fed .5% vs 1% BRU. Supplementation with BICARB decreased ($P < .05$) ruminal VFA concentration and ruminal buffering capacity. Buffer supplementation decreased ($P < .05$) ruminal protozoa. Neither BRU nor BICARB were effective in modulating effects of a glucose challenge on ruminal digestive function.

Key Words: Cattle, Magnesium Hydroxide, Sodium Bicarbonate

1283 The effects of Bio-chlor™ and anionic salts fed prepartum on health and production in a commercial dairy. D. S. Tsang¹, R. D. Allshouse¹, C. S. Ballard¹, C. J. Sniffen^{*1}, and S. Miyoshi², ¹W.H. Miner Agric. Res. Institute, Chazy, NY, ²Zen-Noh, Japan.

The effects of Bio-chlor™ and anionic salts fed to prepartum cows was evaluated by measuring urine pH, milk production and composition, body condition score, serum chemistry, urine ketones and reproductive performance. Eighty-six multiparous Holstein cows from a commercial dairy were blocked by parity, projected calving date and PTA milk. Three wk prior to calving, cows were randomly assigned to one of two treatments 1) Closeup diet + Anionic Salts (Anionic Salts) or 2) Closeup diet + Bio-chlor™ (Bio-chlor). The Closeup diet was composed of corn silage, grass silage, triticale and oat silage, chopped hay, soy straw, high moisture ear corn, roasted soybeans and brewers grains and fed as a total mixed ration. A concentrate mash was formulated for each treatment to balance the diet. The anionic salts used were calcium carbonate, magnesium oxide, and magnesium sulfate. At calving, cows were placed on a transition diet for 14 d and then moved to a lactation diet. The calculated cation anion balance (CAB), [(Na + K) - (S + Cl)], was 24 and -7 meq/100 g of DM for Anionic Salts and Bio-chlor, respectively. There were no cases of milk fever and incidence of other health problems was similar for both treatments ($P > .10$). Milk production for Anionic Salts and Bio-chlor for wk 1-4, 35.6 vs. 36.6 kg/d (SE=0.85), and for wk 5-8, 43.2 vs. 43.1 kg/d (SE=0.94) was not different ($P > .10$). Milk crude protein was lower for Bio-chlor in wk 1-4, 3.29 vs. 3.40 % ($P = .06$), and milk true protein was lower for Bio-chlor in wk 5-8, 2.66 vs. 2.75 % ($P = .07$). Milk urea nitrogen in wk 1-4, 16.57 vs. 15.46 mg/dl was higher for Bio-chlor ($P = .08$). Body condition score was the same at 3 wk prepartum, 3.64 and 3.72 for Anionic salts and Bio-chlor ($P > .10$), respectively. Although there were no differences in milk production, the Bio-chlor group lost more body condition and lost it earlier than the Anionic Salts group. By wk 4 of lactation, the loss in body condition score was -0.65 ± 0.07 vs. -0.84 ± 0.07 condition score units, for Anionic Salts and Bio-chlor ($P = .05$). It appears that feeding Bio-chlor™ in a total mixed ration effectively controlled the CAB of the ration to the same degree as the anionic salts. There were few differences in milk production, milk composition, serum chemistry, health and reproduction between treatments. Feeding Bio-chlor™ 3 wk prepartum enables producers to obtain a lower dietary CAB.

Key Words: Cation Anion Balance, Transition Cows

1284 Environmental Impact of Dairy Farming on Water Quality - A case study. S. J. Wang^{*1}, D. G. Fox¹, D. J. R. Cherney¹, S. D. Klausner², and D. R. Bouldin², ¹Dept of Animal Science, Cornell University and ²SCAS, Cornell University, Ithaca, NY.

The Cornell Teaching and Research dairy farm was used to study the historical influence of dairy farming on water quality and soil chemical properties. The farm has had approximately 350 lactating cows for the past 20 yr and is situated on 485 ha near Harford, New York. Mass nutrient balances (N, P, K) were constructed using historical data from 1979, 1994, 1995 and 1996. The amount of imported N increased two-fold from 1979 to 1995, although there were year to year variations, depending on cropping year (43, 93, 105 and 77 mt for 1979, 1994, 1995, and 1996, respectively). Although percent nutrients retained on the farm remained relatively unchanged during this period ($70 \pm 4\%$), the total metric tons of retained imported N doubled. Imported P and K had similar trends. During this period, milk production increased significantly (14 to 22 mt from 1979 to 1996). Of six sampled wells located in corn fields, five wells more than doubled in nitrate concentration ($P < 0.01$) and the other increased 1.4 fold ($P < 0.01$). Soil pH increased ($P < 0.01$) from 5.69 in 1979 to 6.97 in 1994. Morgan's extract soil test P increased ($P < 0.01$) from 7.35 to 29.78 (kg/ha) during the same period. Soil K did not change. 90% of water leaves the farm through aquifer, and because most of the cropland has little runoff, the aquifer contained very low concentration of P. Mass nutrient balances are important to relate the amount of nutrients remaining on farm to potential for water quality problems.

Key Words: Dairy Farm, Nitrate, Mass Nutrient Balance

1285 Influence of supplemental Cu and Zn on beef heifer performance. B. K. Wellington^{*}, J. A. Paterson, R. P. Ansotegui, C. K. Swenson, and A. B. Johnson, *Montana State University-Bozeman.*

The objective of this experiment was to understand implications of supplementing Cu alone, Zn alone or in combination, for weaned heifer calves (avg. 267 kg) fed a diet high in Mo (41 mg/d). Thirty individually fed calves were allotted by weight to a $2 \times 2 + 1$ factorial arrangement of treatments, comparing different levels of supplemental Cu and Zn in an organic-complexed form. A basal ration (10% protein) of chopped grass hay (76%) and a corn-based concentrate (24%) was fed to provide a .7 kg/day (6.8 kg DM /d) gain for 90 d. Treatments were control (CON; 75 mg/d Cu, 204 mg/d Zn); high Cu (HC; 143 mg/d Cu, 204 mg/d Zn); high Zn (HZ; 75 mg/d Cu, 612 mg/d Zn); high Cu and high Zn in organic-complex form (HCZ-CX; 143 mg/d Cu, and 612 mg/d Zn) and a treatment of high Cu and high Zn in inorganic sulfate form, (HCZ-IN; 143 mg/d Cu, 612 mg/d Zn) to compare to HCZ-CX. Mo was added to all treatments to deplete liver Cu and/or interfere with Cu absorption. Liver biopsies were conducted on d 1, 15, 58, and 90 of the experiment, and were analyzed for Cu and Zn. Feed intakes tended ($P < 0.15$) to be higher for diets without Zn (avg. 7.6 kg/d) compared to diets with Zn (avg. 6.6 kg/d). Supplementing Cu tended ($P < 0.19$) to result in faster daily gains than diets without Cu, (avg. .44 vs .37 kg/d; respectively). Similarly, gains tended to be faster for Zn supplementation vs no Zn supplementation ($P = .19$). There were no significant differences in rate and efficiency of gain when HCZ-CX was compared to HCZ-IN. Feed efficiencies were numerically improved ($P < 0.16$) for Zn supplementation (avg. 14.8) compared to no Zn, (avg. 18.5). Heifers fed HCZ-CX had a greater increase in liver Cu over the 90 d (203%) followed by HC (124%) and CON (108%). When heifers were fed HZ, liver Cu levels declined to 59% of the initial value. There was no difference for Cu uptake, as a percentage of initial liver concentration, when comparing HCZ-CX to HCZ-IN. These data suggest that supplemental Cu and Zn had a greater effect for increasing liver Cu stores than did supplementing Cu only.

Key Words: Minerals, Beef, Copper

1286 Refinement of retinyl palmitate assay reveals earlier assays grossly overestimate concentrations in plasma. D. R. Zimmerman^{*1}, R. L. Horst², J. P. Goff², D. A. Hoy², and D. C. Beitz¹, ¹Iowa State University, Ames, ²National Animal Disease Center, USDA-Agricultural Research Service, Ames IA.

Vitamin A status in dairy cows has been determined by plasma concentrations of retinol and retinyl palmitate or retinyl palmitate alone, as analyzed by HPLC from a single column assay. By using this type of analytical system, concentrations of retinyl palmitate as high as 750 ng/mL have been reported. Retinol concentrations in plasma range from 150 ng/mL to 250 ng/mL in normal dairy cows. Unfortunately, the alleged retinyl palmitate peak included other compounds in addition to the retinyl palmitate. We recently developed a quantitative assay for retinol and retinyl palmitate that utilizes a two-column system, resolving retinyl palmitate from other coeluting solutes. The retinyl palmitate peak collected from the first HPLC column was applied to a C18 column with mobile phase of 75:20:5 (v:v:v) methanol:chloroform:water. As a test of this new assay for retinyl palmitate and retinol, ten nonlactating nonpregnant Jersey cows were assigned randomly to one of three oral daily treatments of retinyl palmitate for 14 days: 0, 125,000 IU, or 250,000 IU. Retinyl palmitate concentrations in plasma collected during the 14 days ranged from undetectable to 9 ng/mL without dosing and from undetectable to 9 ng/mL with both doses of retinyl palmitate. Retinol concentrations ranged from 180 to 230 ng/mL without dosing and from 225 to 285 ng/mL with both doses of retinyl palmitate. Retinyl palmitate concentrations of 9 ng/mL are an insignificant proportion of total circulating retinoids since retinol concentrations are normally around 250 ng/mL. Therefore, using retinyl palmitate concentrations in plasma as a diagnostic tool for vitamin A status in dairy cows seems inappropriate.

Key Words: Retinyl Palmitate, Vitamin A, Retinol

1287 Effect of dietary molybdenum and copper on ruminal gas cap H₂S levels and liver copper stores of feedlot steers. G. H. Loneragan¹, J. J. Wagner², D. H. Gould*³, F. B. Garry¹, and S. R. Goodall⁴, *Departments of ¹Clinical Science and ³Pathology, Colorado State University and ²Continental Beef Research, Lamar, CO. Funded in part by the Meat Research Corporation, Australia and ⁴DuCoa, Highland, IL.*

Polioencephalomalacia (PEM) has been associated with pathological ruminal gas cap hydrogen sulfide (H₂S) levels resulting from microbial reduction of excess dietary sulfur (S). Seventy-two crossbred steers (324 kg) were randomly allocated to 1 of 4 treatments with 2 replicates of 9 head per pen. Treatments consisted of Cx (supplemental Cu at 90 mg/kg dry matter (DM) from copper carbonate (CuCO₃)), OrgCu (45 mg/kg DM as Cu from Cu proteinate and 45 mg/kg from CuCO₃), Cx-Mo (Cx plus 100 mg/kg DM as Mo from sodium molybdate) and Cx-Mo-OrgCu (Cx-Mo plus 45 mg/kg DM Cu from Cu proteinate). All cattle received water with approximately 2400 mg sulfate/L. Estimated total S intake varied from 0.3% to 0.6%. One replicate from Cx and one from Cx-Mo-OrgCu were used for ruminal gas cap H₂S estimation by aspiration through an H₂S detector tube. Liver biopsies were taken from 1 replicate of each treatment on days 0 and 42 and analyzed for Cu content. Previous investigations indicate that ruminal H₂S above 1000 ppm is not optimal. Mean ruminal H₂S concentration was reduced ($p < 0.05$) for Cx-Mo-OrgCu (951 ± 94 ppm (Mean ± SE)) compared to Cx (1200 ± 78 ppm). In addition, percent of ruminal H₂S measurements greater than 1000 ppm was reduced ($p < 0.05$) to 30.2% from 50.6%, respectively. Liver Cu levels were similar ($p = 0.66$) between treatments on day 0 but differed ($p = 0.06$) on day 42. Interaction of time and treatment was significant ($p < 0.05$). Liver Cu increased for Cx ($p = 0.06$), did not differ ($p > 0.2$) for Cu-OrgCu, decreased for Cx-Mo ($p < 0.05$) and tended to decrease for Cx-Mo-OrgCu ($p = 0.16$). Pathological ruminal H₂S levels due to excess S intake may be reduced via Mo supplementation at high levels (100 mg/kg). However, this approach is not recommended since cattle that received supplemental Mo had 30% of ruminal H₂S measurements greater than 1000 ppm and decreased liver Cu stores.

Key Words: Hydrogen Sulfide, Molybdenum, Copper

1288 Effect of estrus suppression method and a trenbolone acetate / estradiol implant on growth performance and carcass characteristics of beef heifers. J. Popp*¹, B. Cook², J. Kastelic², T. McAllister², S. Robbins³, and R. Harland³, ¹Alberta Agriculture, Food and Rural Development, Medicine Hat, AB, ²Agriculture and Agri-Food Canada, Lethbridge, AB, ³Biostar Inc., Saskatoon, SK.

The effect of estrus suppression method (none, immunization against GnRH, 0.4 mg d⁻¹ oral melengestrol acetate) and an anabolic implant (none, Revalor H[®]) on growth performance and carcass characteristics were tested using beef heifers (n = 144) in a 2 X 3 factorial experiment conducted 85 d before slaughter. Implanting increased ($P < .05$) rate of gain (1.72 vs. 1.50 kg d⁻¹), feed efficiency (6.02 vs. 6.75 kg DMI kg gain⁻¹), final weight (532.2 vs. 513 kg), carcass weight (301.4 vs. 288.7 kg) and ribeye area (88.6 vs. 85 cm²), but had no effect ($P > .05$) on daily feed consumption, grade fat, marbling and lean yield. Immunization did not affect ($P > .05$) final weight, rate of gain, feed efficiency and intake, carcass weight or marbling. However, heifers immunized against GnRH had a greater ($P < .05$) ribeye area (90.0 vs. 84.6 cm²) and lean yield (63 vs. 61%) and lower ($P < .05$) grade fat (7.5 vs. 8.6 mm) than heifers fed MGA, while control heifers did not differ from either GnRH or MGA. Implanting improved growth performance and carcass characteristics. Immunization against GnRH increased ribeye area and lean yield when compared with MGA, but had no effect on growth performance of heifers.

Key Words: TBA, GnRH, MGA

1289 Influence of degree of restriction on the compensatory gain response of feedlot steers upon refeeding. C. L. Ferrell*, T. G. Jenkins, H. C. Freetly, and J. A. Nienaber, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

An objective of this study was to determine the influence of degree of restriction of a high concentrate diet on the compensatory gain response of feedlot steers upon realimentation. Ninety-six, fall born, MARC III steers (358 + 3.04 kg) were used. Steers were allotted to 16 pens of six steers each and fed a diet (% DM) of 80.00% dry rolled corn, 13.61% corn silage, 4.40% soybean meal, .776% urea, .668% limestone, .433% dicalcium phosphate, .092% salt, .008% trace mineral premix, and .015% monensin premix (Rumensin 80), individually. Two pens of steers were assigned to each of eight dietary treatments (TRT) consisting of 40, 50, 60, 70, 80, 90, 100, and 110 g/kg, 75, daily. Steers were weighed and feed allowances were adjusted at 14-d intervals. At 112 d, all steers were switched to ad libitum. Steers fed at the 80, 90, 100, and 110 levels were slaughtered after 39 d of ad libitum feeding and the remaining steers were slaughtered after 74 d of refeeding. Quadratic regressions of weight on time (days on feed) and cumulative feed intake on time were developed for each steer, within period. Results from those regressions were used to determine initial weight (IWT), mid weight (weight at 112 d; MWT), final weight (FWT), and feed intake during Period 1 (0 to 112 d) and Period 2 (112 d to slaughter). The model used to analyze IWT, MWT, and FWT included TRT and the model used to analyze feed intakes included TRT, period and the interaction. MWT averaged 394, 405, 440, 474, 493, 509, 508, and 525 (SE 3.21), whereas FWT averaged 538, 547, 558, 601, 565, 568, 565, and 585 (SE 3.86) kg for TRT 40, 50, 60, 70, 80, 90, 100, and 110, respectively. Cumulative dry matter intake averaged 389, 485, 599, 718, 822, 911, 939, and 1005 kg during Period 1 and 712, 697, 734, 810, 411, 380, 372, and 400 (SE 5.41) kg during Period 2 for the above treatments, respectively. Steers exhibited compensatory gain during the realimentation period that was linearly ($P < .001$) related to degree of restriction during Period 1, however, no evidence of improved efficiency over the entire feeding interval was observed.

Key Words: Nutrition, Feed Efficiency, Growth

1290 Evaluation of compensatory gain and grazing systems for yearling cattle. D. J. Jordon*, T. J. Klopfenstein, C. T. Milton, G. E. Erickson, and R. J. Cooper, *University of Nebraska, Lincoln.*

A trial was conducted to evaluate compensatory gain and grazing systems in yearling cattle. One hundred and ninety two crossbred steers (247 kg) were used in a completely randomized design with a 2 × 3 factorial treatment arrangement. Cattle were wintered at two rates of gain, .1 (Slow) or .7 kg/d (Fast). Winter gains were achieved by grazing cornstalks (Slow) or cornstalks supplemented with wet corn gluten feed (Fast). The second factor was summer grazing system: bromegrass (B), Sandhills range (SR), or brome/warm season grass rotation (B/WS). The B treatment consisted of cattle removed from pasture and placed into the feedlot at three times during the summer to match bromegrass growth. Upon removal from summer pasture, cattle were weighed, placed in the feedlot, and fed a diet consisting of 45% wet corn gluten feed, 42.5% dry rolled corn, and 7.5% alfalfa. Overall, Fast steers had a lower ($P < .05$) slaughter breakeven compared to Slow (63.99 vs 68.49 \$/45 kg, respectively). Although Slow steers gained faster through the summer period ($P = .0001$), incomplete compensation for reduced winter gains (only 38% compensation through summer grazing) resulted in lower final weights and a higher slaughter breakeven. Steers on B/WS had a lower ($P < .05$) slaughter breakeven compared to steers on B and SR (64.90 vs 66.64 and 67.17, \$/45 kg, respectively). Increased total forage gain (combined winter and summer periods) resulted in higher final weights ($P < .05$) and a reduced slaughter breakeven. Correlation coefficients (r) were calculated to determine which variables had the greatest influence on slaughter breakeven. Higher rate of winter gain ($r = -.89$, $P = .0001$) and increased final weight ($r = -.85$, $P = .0005$) resulted in the lowest slaughter breakevens. Therefore, winter supplementation to increase gains resulted in slaughter breakevens similar to Slow steers if Fast steers maintained at least 16 kg additional weight through marketing. However, Fast steers in this trial maintained 25–86 kg over Slow steers.

Key Words: Compensatory Gain, Grazing Systems, Steers

1291 Influence of feed intake fluctuation and frequency of feeding on rate of passage and total tract digestibility in limit-fed steers. S. A. Soto-Navarro^{*1}, C. R. Krehbiel¹, G. C. Duff², M. L. Galyean³, and M. A. Brown¹, ¹New Mexico State University, Las Cruces, ²Clayton Livestock Research Center, Clayton NM and ³Texas Tech University, Lubbock.

Eleven crossbred beef steers (344 kg) fitted with ruminal cannulas were used in a completely randomized design to evaluate the effects of feeding frequency and feed intake fluctuation on digestive function. Steers were allotted randomly to one of four dietary treatments: 1) feed offered once daily at 0800, 2) feed offered once daily at 0800 with a 10% fluctuation in day-to-day feed intake, 3) feed offered twice daily at 0800 and 1700, and 4) feed offered twice daily at 0800 and 1700 with a 10% fluctuation in a day-to-day feed intake. The diet was a 90% concentrate diet that was fed at 90% of the ad-libitum consumption of each steer. The diet was formulated to contain (DM basis): 13% CP, 8.7% ADF, .61% Ca, 33 mg/kg monensin and 8.8 mg/kg of tylosin. Total feces were collected for a 4-d period. Cr-EDTA was dosed on d 1 and 3 and Co-EDTA was dosed on d 2 and 4 to determine rate of liquid passage. Ruminal samples were taken at 0, 3, 6, 9, 12, 15, 18 and 24 h after the 0800 feeding time. Ruminal volume and rate of passage were not affected ($P > .10$) by frequency of feeding or intake fluctuation. When steers were fed twice daily with a 10% fluctuation in feed intake, total tract DM digestibility was lower ($P < .10$) than when steers were fed a twice daily with no fluctuation in feed intake (88.3 vs 82.9%, respectively). Similarly, organic matter and N digestibility were greater ($P < .10$) when steers were fed twice daily with no fluctuation in feed intake vs steers fed twice daily with a 10% fluctuation in feed intake. Results of this experiment suggest that with twice per day feeding, fluctuation in feed intake decreases digestibility of organic matter and N.

Key Words: Feed Intake, Feedlot, Steers

1292 AgradoTM for finishing cattle: Effects on performance, carcass measurements and meat quality. C. L. Krumsiek^{*1}, F. N. Owens¹, and W. A. Samuels², ¹Oklahoma State University, Stillwater, ²Solutia Inc., St. Louis.

Seventy-five feedlot cattle in 15 pens were fed high concentrate diets supplemented with either 0 or 136 ppm AgradoTM produced by Solutia, Inc., St. Louis, MO for 28 days prior to harvest. Added AgradoTM had little impact on gain, feed intake, or feed efficiency although rate and efficiency of gain tended to be improved (5% and 7.2%) by supplemental AgradoTM. Lean maturity, an indicator of darkness of ribeye color, was reduced ($P < .02$) while USDA yield grade was increased slightly by feeding AgradoTM. Shelf life of both ground beef and ribeye steaks that had been aged for 13 days was monitored for 10 days in a simulated meat counter; samples were appraised visually by a panel of 6 people, electronically with a color reflectance meter, and chemically by measuring thiobarbituric acid equivalents (ground beef only). According to visual estimates, shelf life was extended (6 versus 2 days for ground beef; 4 versus 3 days for ribeye steaks) for beef obtained from cattle that had been fed AgradoTM. Electronic measurements and thiobarbituric acid assays confirmed these visual differences. Eight members of an untrained taste panel were each given one steak from a control animal and one steak from an AgradoTM-fed animal. Steaks, that had been aged for 13 days, vacuum packaged and frozen for 3 weeks, were delivered to each panel member to cook at home. No differences in color, flavor, tenderness, juiciness, and overall acceptability were detected between steaks from cattle fed or not fed AgradoTM. Feces from cattle fed AgradoTM were examined for odor potency and offensiveness; feeding this product reduced odor offensiveness and tended to reduce potency of odor at 6 hours ($P < .08$; $P < .03$) but not at 24 h after collection.

Key Words: Feedlot, Beef, Case Life

1293 Effect of energy restriction or refeeding on LH secretion and metabolic indicators in heifers of distinct body condition. J. M. Cassady^{*}, A. DiCostanzo, B. A. Crooker, and J. E. Wheaton, University of Minnesota, St. Paul.

We previously determined that body condition (BC) and energy intake affect days to anestrus (ACYC) but not days to regain cyclicity (CYC). Thus, our hypothesis was that BC modulates LH response to nutritional manipulation. Twenty pubertal heifers were fed to create two distinct BC groups (INIT): fat (FC) or moderate (MC). Subsequently, heifers were fed a low energy diet until estrous cycles stopped and were then fed a high-energy diet until estrous cycles resumed. Metabolic indicators and LH secretion (concentration, peak amplitude and frequency) were measured at INIT, when heifers were cyclic during restriction (MIDACYC), at ACYC, when heifers were acyclic during refeeding (MIDCYC), and at CYC. At ACYC, LH secretion was lowest ($P < 0.05$) while GH and plasma urea nitrogen concentrations were highest ($P < 0.05$). Insulin (INS) and glucose (GLU) concentrations at ACYC were lower ($P < 0.05$) than at INIT, but differed ($P < 0.05$) due to BC. Insulin was higher and GLU was lower for FC heifers. At CYC, LH concentration and peak amplitude, and INS returned to INIT values in FC, but not in MC heifers. Compared to INIT values, LH concentration and peak amplitude were lower ($P < 0.05$), and INS was higher ($P < 0.05$) in MC heifers. Peak frequency of LH returned to INIT values at CYC regardless ($P > 0.05$) of BC. At MIDACYC, metabolic indicators reflected catabolism, but LH concentration or peak amplitude was unchanged ($P > 0.05$) from INIT values. Relative to INIT values, LH peak frequency at MIDACYC was higher ($P < 0.05$) for FC and lower ($P < 0.05$) for MC heifers. At MIDCYC, metabolic indicators reflected anabolism; LH concentration and peak amplitude in MC heifers increased ($P < 0.05$). Relative to ACYC values, LH peak frequency of MIDCYC was unchanged ($P > 0.05$). When cyclic, LH concentration or peak amplitude did not respond to energy restriction while when acyclic, these traits responded to refeeding and BC. In contrast, LH peak frequency responded to energy restriction and BC, but not to refeeding.

Key Words: LH, Body Condition, Energy

1294 Effects of accelerated growth rates and estrogen implants in prepubertal heifers on subsequent reproduction and milk production. B. P. Lammers^{*}, A. J. Heinrichs, and R. S. Kensingler, The Pennsylvania State University.

This study tests the hypothesis that rearing Holstein heifers greater than 800 g/d and prepubertal estrogen treatment affects mammary development and subsequent milk production. Holstein heifers ($n=58-68$ depending on data) were assigned to one of four treatment groups using a randomized complete block design in a 2x2 factorial arrangement. The treatments were (S) standard growth rate (700 g/d), (A) accelerated growth rate (1,000 g/d), (SE) standard growth rate with an estradiol implant and, (AE) accelerated growth rate with an estradiol implant. The treatments were imposed over 140 days beginning at 4 1/2 months of age and 130 kg body weight (BW). During the treatment period, all heifers were fed in Calan feeding doors and received the same diet (16.0% CP and 2.66 Mcal ME/kg) but DMI of each heifer was adjusted weekly to control growth rate. The estrogen implants were removed at the end of the treatment period (9.5 mo of age). After the treatment period, the heifers were group fed according to BW and age to allow the heifers to have a similar BW and age at calving. Breeding was initiated at thirteen months of age. The accelerated growth regimen decreased the age at puberty 32 days. Age, BW and body condition score (BCS) at calving were not significantly different among treatments. The accelerated prepubertal growth regimen and estrogen implants decreased first lactation milk yields 10 and 9%, respectively.

Item	S	A	SE	AE	S vs A ¹	±E ²
Prepubertal ADG (g/d)	706	1009	704	1005	*	ns
Age at puberty (d)	334	311	358	316	*	ns
Age at calving (mo)	22.9	22.8	23.5	22.7	ns	ns
BW after calving (kg)	547	538	528	530	ns	ns
BCS at calving (1-5)	3.5	3.3	3.5	3.4	ns	ns
200 d Milk yield (kg/d)	29.7	27.1	27.4	24.3	*	*

* $P < 0.01$; ns = not significant; Interactions were not significant.

¹Effect due to growth rate;

²Effect due to estrogen implant.

Key Words: Heifers, Mammary Development, Estrogen

1295 Application of the 1996 Beef NRC model for predicting growth in dairy cattle. D. G. Fox*, M. E. Van Amburgh, and T. P. Tylutki, *Cornell University, Ithaca, NY.*

The 1996 National Research Council Beef Cattle growth model was modified for computing growth and target weights for dairy cattle. The size scaling system of the 1996 Beef NRC is used to adjust shrunk body weight (SBW) to a weight equivalent to a standard reference animal at the same stage of growth (EQSBW); $EQSBW = SBW * (478/MSBW)$, where 478 kg is mature weight of the standard reference animal and MSBW is expected heifer mature shrunk body weight. Equivalent empty body weight (EQEBW) is $0.891 * EQSBW$ and empty body gain (EBG) is $0.956 * SBG$, which are used to predict required net energy for gain (NEg); $NEg, \text{ mcal/d} = 0.0635 * EQEBW^{.75} * EBG^{1.097}$. Net energy available for gain (NEFG) is used to predict SWG; $SWG, \text{ mcal/d} = 13.91 * NEFG^{.9116} * EQSBW^{-.6837}$. Net protein required for gain (NPg, g/d) = $SWG * (268 - (29.4 * (NEg/SWG)))$. Absorbed protein requirement is $NPg / (0.83 - (EQSBW * 0.00114))$. In an evaluation with heifer body composition data, the equations presented accounted for 93% of the variation in energy and 69% of the protein retained. Target first conception and post first, second, third, and fourth calving weights are 55, 82, 92 and 96% of mature weight. These are used to compute required SWG based on target days to calving.

Current SBW	Mature body weight					
	600		700		800	
	150	350	150	350	150	350
SWG	NEg required, mcal/d					
0.6	1.14	2.16	1.02	1.92	0.92	1.74
1.0	2.00	3.78	1.78	3.37	1.61	3.05
	NPg required, g/d					
0.6	127	97	131	104	134	110
1.0	209	157	216	169	221	178
Minimum post calving weights, kg						
first conception	330	385	440			
first calving	492	574	656			
second calving	552	644	736			
third calving	576	672	768			
fourth calving	600	700	800			

Key Words: Energy Requirements, Protein Requirements, Heifer Growth

1296 Effects of graded levels of ruminally protected choline on growth, intake, and serum metabolite and hormone concentrations in lambs fed a high-concentrate diet. T. C. Bryant*¹, J. D. Rivera¹, M. L. Galyean², D. M. Hallford³, and L. J. Perino¹, ¹West Texas A & M University, Canyon, ²Texas Tech University, Lubbock, and ³New Mexico State University, Las Cruces.

Twenty wether lambs (average initial BW = 30 kg) fed an 80% concentrate (steam-flaked corn base) diet were used to determine the effects of graded levels of ruminally protected choline (RPC) on performance, DMI, and serum GH, insulin (INS), and NEFA concentrations. Lambs were individually penned, adapted to ad libitum consumption of the 80% concentrate diet, stratified by BW, and assigned randomly, within strata, to diets containing either 0, .25, .50, or 1.0% RPC (five lambs per treatment). Daily DMI, ADG, and feed:gain ratio were determined for two 28-d periods and for the overall 56-d trial and were analyzed using initial BW as a covariate. On d 28 and 56, blood was sampled via jugular catheters at 15 min before feeding and again at 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330, 360, and 480 min after feeding. Serum was assayed for concentrations of GH, INS, and NEFA. Feed efficiency, ADG, and daily DMI did not differ ($P > .10$) among treatments. Within d-28 serum samples, GH concentrations (2.06, 2.59, 2.24, and 2.35 ng/mL for 0, .25, .50 and 1.0% RPC, respectively) were greater ($P = .02$) for .25% RPC than for 0% RPC; however, no differences ($P > .40$) were detected among treatments for GH on d 56. In contrast, d-28 serum INS concentrations (.90, 1.10, 1.51, and 3.09 ng/mL for 0, .25, .50, and 1.0% RPC, respectively) tended ($P < .07$) to be greater when lambs were fed 1.0% RPC than when lambs were fed 0% or .25% RPC; however, serum INS was not affected ($P > .50$) by RPC level on d 56. No differences ($P > .50$) were detected among treatments for serum NEFA on either d 28 or d 56. Results of this trial suggest that ruminally protected choline can alter metabolic hormone responses in growing/finishing lambs.

Key Words: Choline, Sheep, Growth

1297 Effects of ruminally protected choline and dietary fat on performance of finishing heifers. D. J. Bindel*, J. S. Drouillard, E. C. Titgemeyer, R. H. Wessels, and C. A. Loest, *Kansas State University, Manhattan.*

A 120-d finishing study utilizing 318 heifers (342 kg initial BW) was conducted as a complete block design to examine effects of ruminally protected choline in diets containing graded levels of tallow. Heifers were blocked according to previous nutrition (full-fed or ad-libitum fed) and were allotted to one of 12 treatments. Pens contained 11 to 15 heifers. Two pens, one within each block, were assigned to each treatment. Treatments were levels of added tallow (0, 2, or 4%) and graded levels of encapsulated choline (0, 20, 40, or 60 g product daily, estimated to supply 0, 5, 10, or 15 g/d choline post-ruminally; Balchem Corp., Slate Hill, NY). Heifers were fed a finishing diet based on steam-flaked and dry-rolled corn (12.5% CP, 8% alfalfa on DM basis). Heifers were implanted with Revalor[®]-H. DMI decreased ($P < .05$) by 5.4% when tallow was increased from 0 to 4%, but was not affected by addition of choline ($P > .49$). Heifers receiving supplemental tallow at the 4% level had 7.3% lower gains than those receiving no added tallow ($P < .05$). Choline supplementation increased (linear, $P < .1$; quadratic, $P < .05$) ADG; feeding 20 g daily of encapsulated choline increased ADG by 8.6% relative to control heifers. Likewise, feed efficiency improved ($P < .1$) when heifers were supplemented choline with a 7.6% response occurring between 0 and 20 g/d. Yield grade and kidney, pelvic, and heart fat both increased linearly ($P < .1$) with fat supplementation. The percentage of carcasses grading USDA Choice decreased (linear, $P < .05$; quadratic, $P < .1$) with the highest level of choline supplementation. Dressing percent, hot carcass weight, marbling, and 12th rib fat thickness were not significantly affected by either fat or choline. Moderate levels of supplemental encapsulated choline can improve growth performance of finishing cattle with no negative effect on carcass characteristics. Optimum performance was achieved with 20 g product daily. Increases in encapsulated choline above 40 g/d yielded no additional benefits.

Key Words: Choline, Performance, Heifers

1298 Effect of moist heat treatment on protein quality of mustard meal. A. F. Mustafa*, J. J. McKinnon, and D. A. Christensen, *Department of Animal and Poultry Science, University of Saskatchewan.*

A study was conducted to determine the effects of autoclaving (127°C, 117 kPa steam pressure for 10 min on CP fractions and in vitro CP degradability (IVCPD) of mustard meal. Rumen undegraded protein (RUP) and amino acid disappearance of heated and unheated mustard meal was measured following 12 h of rumen incubation. Intestinal availability of RUP was estimated using an enzymatic (pepsin-pancreatin) procedure. Heat treatment reduced ($P < 0.05$) CP solubility and increased ($P < 0.05$) neutral detergent insoluble CP without affecting acid detergent insoluble CP. Relative to the control, heated mustard meal had lower ($P < 0.05$) IVCPD (44.5 vs 74.7%) and higher ($P < 0.05$) ruminal escape CP (61.5 vs 12%) value. Heat treatment increased ($P < 0.05$) the amount of CP available for digestion in the small intestine from 7.6 to 51.8%. Amino acid composition was not affected by heat treatment except for arginine and lysine which were lower ($P < 0.05$) in heated than unheated meal. Disappearance of all amino acids following 12 h of rumen incubation was higher ($P < 0.05$) in unheated than heated mustard meal. It was concluded that autoclaving of mustard meal for 10 min reduced ruminal CP and amino acid degradability of mustard meal without compromising the intestinal availability of RUP.

Key Words: Heat Treatment, Protein Degradability, Mustard Meal

1299 Effect of three different solids retention times on protein degradation of two feeds. I. Schadt¹*, W. H. Hoover², T. K. Miller Webster², W. V. Thayne², and G. Licita¹, ¹*Consorzio Ricerca Fileria Lattiero-Casearia, University of Catania, Italy*, ²*West Virginia University, Morgantown*.

Effects of solids retention times (SRT) of 10, 20 and 30h on protein degradation and microbial metabolism were studied in continuous cultures of rumen contents. Two semi-purified diets containing either soybean meal (SBM) or alfalfa hay (ALFH) as the sole nitrogen source were provided in amounts that decreased as SRT was increased. Digestion coefficients for DM, NDF, and ADF increased with increasing SRT. Digestion coefficients for nonstructural carbohydrates were higher in the SBM diet than in the ALFH diet, but were not affected by SRT. Microbial efficiency, expressed as g N / kg digested DM, increased with increasing solids passage rates, and was greater for the SBM than the ALFH diet. Efficiencies ranged from 30.6 to 35.7 and 20.8 to 29.2 for the SBM and ALFH diets, respectively, as SRT decreased from 30 to 10 h. The diaminoimelic acid content of the microbes increased as SRT increased, indicating changes in microbial species due to passage rates. Protein degradation in the ALFH diet averaged 51%, and was unaffected by retention time. In the SBM diet, digestion of protein was 77, 78, and 96% at 10, 20, and 30 h retention times, respectively. Results indicate differences in microbial metabolism and protein degradation due to feed sources are important.

Key Words: Retention Time, Digestibility, Continuous Culture

1300 The effect of level and source of protein on ruminal fermentation, microbial efficiency and amino acid flow and digestibility in steers. M. E. Costas*, J. N. Spain, M. S. Kerley, and J. E. Williams, *University of Missouri - Columbia*.

Four multi-cannulated Holstein steers were used in a 4 × 4 Latin square to describe the site and extent of digestion and total tract digestibility of four diets: (1) 14% CP and 45% UIP, 2) 16% CP and 39% UIP, 3) 16% CP and 45% UIP and 4) 18% CP and 39% UIP). Each 10 day period consisted of a 7 day adaptation phase followed by a 3 day sampling phase. Total VFA production and molar proportions of each VFA were not affected by diet. Ruminal ammonia N increased (P < .001) with increasing levels of protein. The N and AA composition of bacteria did not differ due to treatments. Microbial AA, duodenal AA and ileal AA flows were not affected (P > .15) by level or type of protein. The apparent absorption of AA in the small intestine were similar (P > .15) for all treatments. Lysine and methionine flow and apparent absorption, as a percent of total essential AA, did not differ (P > .15) with increasing levels of protein. Increasing the level of CP above 14% did not enhance microbial yield or fermentation efficiency. Total N flow was not affected by level of protein because of the low dilution rate which resulted in extensive ruminal fermentation and deamination of the supplemental protein. Microbial AA flow was not affected. Increasing the level of CP above 14% did not alter flow of digestible amino acids in cannulated steers.

Key Words: Ruminant, Amino Acids, Digestibility

1301 Evaluation of condensed porcine solubles as a source of supplemental nitrogen in corn-based finishing diets for yearling steers. J. C. Iiams*, A. Trenkle, *Iowa State University, Ames, IA*.

Ninety-six crossbred yearling steers averaging 390 kg were used in a 121-d feeding trial to evaluate Condensed Porcine Solubles (CPS) as a source of supplemental nitrogen for finishing cattle. CPS, a coproduct remaining after extraction of heparin from porcine intestine, is rich in peptides, amino acids, and significant levels of fat. High-corn diets supplemented with 1.46% urea, 5% SBM, and 2% or 4% CPS were compared. Following a 21-d adaptation, feed containing up to 4% CPS was readily consumed. On a DM basis, diets contained 13% CP with sulfur concentrations of .206, .2, .268, .378 percent in the urea, SBM, 2% CPS, and 4% CPS supplemented diets, respectively. During the first 56-d, steers fed SBM gained 1.87 kg/d which was 11% faster (P < .10) than steers fed 2% CPS and 21% faster (P < .01) than steers fed 4% CPS. At the end of the trial there were no differences among the nitrogen supplements in feed intake, gain, or feed conversion. There were no significant differences in carcass weight or measures of carcass quality. Mean feedlot performance and carcass characteristics of steers fed 121 days are presented below. From this study, it seems that CPS could furnish a portion of the supplemental nitrogen for steers fed high-corn diets.

Item	Diets				SEM
	1.46% Urea	5% SBM	2% CPS	4% CPS	
n	24	24	24	22 ^a	
Daily gain, kg	1.67	1.71	1.70	1.66	.03
Intake, kg DM	9.66	9.89	9.89	9.53	.11
Gain/feed	.173	.173	.172	.174	.002
Carcass wt, kg	356.0	359.5	362.7	362.2	2.8
Ribeye area, cm ²	89.0	86.4	86.4	87.7	.84
Fat cover, cm	.56	.74	.79	.74	.05
USDA Choice, %	62.5	91.7	87.0	77.3	5.0
Avg yield grade	1.79	1.96	2.08	1.90	.05

^aOne steer removed from each of two pens because of diagnosed polioen- cephalomalacia.

Key Words: Steers, Nitrogen supplement, Feedlot

1302 Limiting amino acids for growing cattle fed soybean hull-based diets. R. H. Greenwood*, E. C. Titgemeyer, and C. A. Loest, *Kansas State University, Manhattan*.

Three N balance experiments were conducted to determine the sequence of limiting amino acids (AA) for growing steers fed soybean hull-based diets. Ruminally cannulated Holstein steers were maintained in metabolism crates, fed the same basal diet (73% soyhulls, 19% alfalfa DM basis; formulated to minimize UIP supply), and given the same intraruminal infusions (400 g/d acetate; to increase energy supply without increasing microbial protein supply) for all three experiments. Experiment 1 used 5 steers (200 kg) in a replicated 3 × 3 Latin Square with one missing steer. Steers were fed 3.4 kg/d (as fed), and treatments consisted of abomasal infusions of (g/d): 1) control (water, no AA); 2) L-met (10; MET); and 3) L-met (10), L-lys (15.8), L- his (7.4), L-phe (10), L-trp (4.9), L-leu (20), L-ile (10), L-val (10), L-arg (10), and L-thr (10) (TEN). Nitrogen retention was greatest (P < .05) for steers receiving TEN (13.7 g/d), and steers receiving MET (7.9 g/d) had greater (P < .05) N retention than control steers (5.4 g/d). Experiment 2 used 5 steers (200 kg) in a 2-period cross-over design fed 3.4 kg/d (as fed) with treatments consisting of TEN or TEN without L-lys (NOLYS). Steers receiving TEN tended (P < .09) to have greater N retention (19.0 g/d) than those receiving NOLYS (16.3 g/d). Experiment 3 used 6 steers (194 kg) in a 2-period cross-over design fed 3.5 kg/d (as fed) with treatments consisting of TEN (L-lys = 19.7 g/d) or TEN without L-thr (NOTHR). Nitrogen retention was not different between TEN (17.8 g/d) or NOTHR (17.3 g/d). We conclude that methionine was the first limiting AA and that threonine was not limiting for steers fed soybean hull-based diets. Lysine appeared to be a limiting AA, but an untested amino acid(s) appears to be second most limiting. Our data does not support the concept that the sequence of limiting AA for steers is methionine, lysine, and threonine when microbial protein is the primary contributor to metabolizable protein.

Key Words: Steers, Amino Acids, Growth

1303 In vivo metabolism of nitrogen from ¹⁵N-labelled alfalfa preserved as hay or silage. A. N. Hristov*¹, P. Huhtanen², L. M. Rode¹, T. A. McAllister¹, and S. N. Acharya¹, ¹Agriculture and Agri-Food Canada, Lethbridge (Canada), ²Agricultural Research Centre, Jokioinen (Finland).

Natural labelling of forage protein is an attractive technique for studying differences in nitrogen metabolism by ruminants in relation to the type or method of preservation of the forage fed. AC Blue J alfalfa (*Medicago sativa* L.) was grown in greenhouse pots and received 11.13 mg ¹⁵N (as (¹⁵NH₄)₂SO₄) per pot per month. Second cut was harvested at early bloom and preserved as sun-cured hay or as silage at 31% DM content. ¹⁵N-Enrichments of the original plant-, hay- and silage-N were (as atom % excess ± SD): 3.1724 ± .096, 2.802 ± .010 and 3.301 ± .005, respectively. Two Holstein cows in late lactation (consuming 17.0 ± .45 kg DM d⁻¹ and producing 18.5 ± 1.73 kg d⁻¹ of milk) were provided *ad libitum* access to 70% forage:30% concentrate diets based either on alfalfa hay or alfalfa silage. After 14 d, the cows were given *per os* a single pulse dose of ¹⁵N as labelled hay (AH) or silage (AS), yielding ¹⁵N doses of 1469.1 and 758.8 mg per animal, respectively. The kinetics of the N marker were followed for 72 h after dosing in ruminal, duodenal and excreta N pools and ¹⁵N-enrichment curves were plotted. For both preservation methods, the areas under the enrichment curves were highest (*P* < .05) for the ruminal bacterial N pool, followed by urinary N, protozoal N pool and faecal N pool (*P* < .05), calculated as (atom % excess × time (h)): 6.490, 5.710, 5.452 and 5.373 (AH) and 2.124, 1.822, 1.299 and 1.357 (AS), respectively. The faecal-ADF-N pool was considered to be unavailable for digestion throughout the gastro-intestinal tract, and was used to adjust data for the difference in ¹⁵N dose given. Computed as a proportion of the area under the faecal-ADF-¹⁵N enrichment curve, AS had a larger (*P* < .06) relative area of bacterial ¹⁵N-enrichment than AH (2.399 vs 1.557). Relative ¹⁵N-enrichment areas for urinary-N and faecal-N were larger (*P* < .10) for AS than for AH (2.059 vs 1.369 and 1.529 vs 1.290, respectively). Data suggest that nitrogen in alfalfa silage was better utilized by ruminal bacteria for protein synthesis than was N in alfalfa hay, but overall utilization of N by the ruminant was poorer with AS than with AH.

Key Words: Alfalfa, Isotope Labelling, Rumen

1304 In vitro urea kinetics and digestion of forage-only or mixed substrates supplemented with the novel urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT). P. A. Ludden*¹, D. L. Harmon¹, B. T. Larson¹, and D. E. Axe², ¹University of Kentucky, Lexington, ²IMC-Agrico Co., Bannockburn, IL.

Methods of retarding excessive NH₃ release from NPN could potentially improve efficiency of supplemental N utilization. Our objective was to compare in vitro urea kinetics and digestion of forage-only or mixed forage-grain substrates in response to addition of the novel urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT). In vitro incubations were conducted in 50 mL test tubes containing either .5 g ground fescue hay or .5 g of a ground fescue hay and ground corn mixture (50:50) to which was added 20 mL buffer containing 1g/L urea and 10 mL ruminal fluid obtained from a donor animal fed a 70% fescue hay:30% concentrate diet. A solution containing 25% NBPT (IMC-Agrico Co.) was added to supply 0, 6.5, 13, 26, or 52 mg NBPT per tube. All tubes were incubated in triplicate at 39°C and replicated on consecutive days, with NH₃ and urea concentrations measured at 0, .5, 1, 2, 4, 8, 12, 24, and 48 h. At 48 h, samples for VFA analysis were collected and true digestibility (based on NDF analysis) was estimated. No (*P* > .10) NBPT dose by substrate interactions were noted; therefore the main effects of NBPT addition are presented below. Increasing the dose of NBPT depressed the rate of urea hydrolysis and subsequent NH₃ formation. Although total VFA concentration was unaffected (*P* > .10), the acetate:propionate and estimated true digestibility decreased with higher levels of NBPT addition. We conclude that NBPT reduces the rate of NH₃ release from NPN irrespective of substrate, and thereby offers the potential to improve NPN utilization.

	NBPT, mg/tube					SE	Lin	Quad
	0	6.5	13	26	52			
NH ₃ , mM at 12h	16.98	12.61	10.18	2.87	.16	2.27	.0003	.0063
Urea, mM at 12h	.05	2.71	4.28	8.66	10.21	1.24	.0001	.0007
NH ₃ , h ⁻¹	.045	.049	.050	.024	.016	.007	.0030	.2662
Urea, h ⁻¹	-.124	-.113	-.135	-.003	<.01	.011	.0001	.0007
Digestibility, %	83.41	82.59	82.91	79.60	71.66	2.09	.0014	.7527
Acetate:propionate	2.65	1.99	1.76	1.60	1.65	.06	.0001	.0001

Key Words: Urease Inhibitor, Ruminal Ammonia, Urea

1305 Effects of dietary nitrogen manipulation on ammonia volatilization from manure from Holstein heifers. T. A. James*, D. Meyer, E. J. DePeters, E. Esparza, and H. Perez-Monti, University of California, Davis.

Decomposition of livestock manure produces gaseous ammonia. The resulting enrichment of the atmosphere contributes to formation of secondary particulates. Dietary manipulation has been proposed as a means to reduce N in manure and subsequent ammonia volatilization. The effects of dietary CP on N intake, N and urea-N excretion, and ammonia volatilization were measured. Eight Holstein heifers (BW=486 to 341 kg) were fed a TMR containing either 12% or 15% CP in a cross-over design. Oatlage and concentrate were fed at 77:23 (DM basis), and soybean meal was used to alter total dietary CP. Silage samples were evaluated daily for DM. Heifers were tied in individual stalls with a metered waterer and feed bunk. Animals were fed twice daily. Daily orts were weighed and sampled. A 7d adjustment period preceded a 5 d collection period. Indwelling urinary catheters were inserted 2 d prior to the collection period. Daily feces and acidified urine were mixed, collected and subsampled for Total Kjeldahl N, urea-N, DM, P, K and ash. Urine collection tubes were split during period 2 to allow for collection of unacidified samples for urea-N and total N determinations. Feces and unacidified urine samples were mixed (1:1.3) and incubated in a 28° C water bath for collection of volatilized ammonia. Remaining substrates were extracted for total N and urea-N. Least squares means by diet (12 vs 15% CP) for DMI, N intake, N excretion, urea-N excretion, and N excreted in the urine were 7.2, 7.4 kg/d; 111.0, 120.0 g/d; 106.7, 123.0 g/d; 23.3, 42.0 g/d; and 57.8, 62.4%; with SEM of 0.05, 0.5, 1.5, 4.4, and 0.8. Variation in ammonia volatilization, N loss and urea-N loss from manure were explained by the total N in the urine, urea-N, and cow (*P*<.05) [R²=0.74, 0.87 and 0.97]. Reduction of dietary N reduces total N, urea-N and % N excreted in the urine of Holstein heifers. Ammonia volatilization is dependent on N content in the urine and not on total N intake or excretion.

Key Words: Ammonia, Volatilization

1306 Use of heat stable amylase in the neutral detergent fiber procedure. V. L. Nsereko*, K. A. Beauchemin, L. M. Rode, A. A. Furtado, and B. Farr, Research Center, Agriculture and Agri-food Canada Lethbride, AB, Canada.

The use of a heat stable amylase at high temperatures in the NDF procedure is advocated as a means of removing starch interference while minimising side activities. However, thermostability of amylases has only been demonstrated in buffers containing Ca²⁺ and not in ND solution. Amylase No A3306 (Sigma Chem. Co., St. Louis MO), Termamyl 120L, Type L (Novo Nordisk BioChem, Franlinton, FC) and Taka-Therm L-340 (Ankom Tech., Fairport, NY) were evaluated for use in the ND procedure by measuring activities against purified starch, carboxymethyl cellulose (CMC) and oat xylan at pH 7.0. Activities were determined at 30 to 96°C using enzyme and substrate solutions prepared in 0.05M citrate phosphate buffer (CPB) or ND solution, at 0.08 and 2.5 μl enzyme/100mg substrate, respectively. In addition, activities against starch (2.5 μl enzyme/100mg) were determined at 40°C in ND solution without ethylene diaminetetraacetic acid (EDTA), ND solution without sodium dodecyl sulphate (SDS) and ND solution with sodium sulphite (5mg/ml final concentration). Maximum amyolytic activities in CPB were at 50 to 60°C; however, activities reduced to 0.05 or less of the maximum at temperatures above 70°C. In ND solution, maximum amyolytic activities were at 40°C, with little activity remaining above 50°C. Maximum amyolytic activities of Termamyl and Taka-Therm in ND solution were equivalent to 0.85 and 0.81 that of the Sigma product, respectively. Side activities were low in both CPB and ND solution. However at 95°C, xylanase activities in Termamyl and Taka-Therm were greater than the corresponding amylase activities. Removal of SDS and EDTA from ND solution increased amyolytic activities by at least 2 fold and 1.5 fold, respectively for all products. Sodium sulphite reduced amylase activities to 0.9 and 0.8 for Sigma amylase and the other products, respectively. Amylase activities of all products were not stable to boiling in ND solution. Exposing feed samples to amylase in ND solution at 40°C prior to boiling may be a more effective method of removing starch interference.

Key Words: NDF Procedure, Amylases, Thermostability

1307 Effect of high oil corn feeding on carcass traits, tenderness, and fatty acid composition of feedlot steers. J. G. Andrae^{*1}, S. K. Duckett¹, C. W. Hunt¹, M. A. McGuire¹, G. T. Pritchard¹, and P. Feng², ¹University of Idaho, Moscow and ²Optimum Grains, Des Moines, IA.

Sixty head of yearling, Angus-cross steers were used to assess the effect of high oil corn on carcass characteristics, longissimus muscle tenderness and fatty acid composition. Steers were fed the following diets: control corn, (C: 82% of ration), high oil corn (HO; 82% of ration), or high oil corn fed at a level isocaloric to C (ISO; 74% of ration). Cattle were individually fed twice daily using electronic gates for 84 d. At 72 h post-mortem, carcass data was collected from all carcasses. Rib sections were randomly selected from ten carcasses from each treatment, vacuum packaged, and aged for 14 d. Two steaks (2.54 cm thick) were removed from each rib for subsequent Warner-Bratzler shear force (WBS) and fatty acid composition analyses. Pre-planned contrasts between HO and C, and ISO and C were used to assess treatment differences. No treatment differences were observed ($P > .05$) for hot carcass weight, dressing percentage, fat thickness, ribeye area, kidney pelvic and heart fat percent, yield grade and skeletal maturity. Marbling score and quality grades were higher ($P < .05$) for HO than C. However, marbling scores and quality grades did not differ ($P > .05$) between ISO and C. Overall 78% of HO steers graded U.S. Choice compared to 47% for C and 67% for ISO. Warner-Bratzler shear force of the rib steaks were not different ($P > .05$) in either contrast. Feeding HO corn tended ($P = .07$) to decrease saturated fatty acid content and increase ($P = .06$) C18:2, C20:4, and total polyunsaturated fatty acid (PUFA) content when compared to C. Feeding HO corn tended to increase ($P = .08$) C15:0 and increased ($P < .05$) C17:0 and total odd chain fatty acid content. Feeding ISO diet tended ($P = .07$) to reduce C14:0 and C16:0, and increase ($P < .05$) C18:2, C20:4 and PUFA. Feeding HO corn changed intramuscular lipid amount and degree of unsaturation.

Key Words: Beef, Lipid, Tenderness

1308 Effect of high oil corn on growth performance of beef cattle fed finishing diets. J. G. Andrae¹, C. W. Hunt¹, S. K. Duckett¹, G. T. Pritchard^{*1}, and P. Feng², ¹University of Idaho, Moscow and ²Optimum Quality Grains, Des Moines, IA.

Recent development of corn having a genetically greater oil content offers the opportunity to increase the energy density of beef finishing diets. Sixty Angus-based crossbred yearling steers (initial BW = 412 kg) were used to evaluate the effects of high oil corn in a finishing trial. Steers were initially implanted with Synovex-S and then adjusted to a high-grain diet over a 21-d adaptation period. Steers were then allotted by weight to the following dietary treatments: 1) control corn (C; 82% normal corn, 12% silage), 2) High oil corn (HO; 82% high oil corn, 12% silage), and 3) high oil corn formulated to be isocaloric to C (ISO; 74% high oil corn, 20% silage). Total lipid (solvent extracted) content was 4.86% on a DM basis for normal corn and 7.04% for high oil corn. Diets were formulated to be isonitrogenous by adjusting the dietary urea content. Steers were fed individually using electronic gates. Weights of feed offered and feed refused were recorded daily. Steers were weighed following an overnight stand without water on consecutive days at the beginning and end of the 84-d study. Dry matter intake was higher ($P < .01$) for steers fed C than HO and ISO diets (11.8 versus 10.9 and 11.1 kg/d). Daily gain was not affected ($P > .10$) by dietary treatment; however, steers fed both HO and ISO diets had numerically lower ADG than steers fed C (1.94 and 1.99 versus 2.05 kg/d). Opposing treatment response for DMI and ADG resulted in similar feed efficiency for the dietary treatments (feed: gain = 5.68, 5.56, and 5.79 for HO, ISO and C, respectively). Failure of high oil corn to improve growth performance under the conditions of this study may be due to relatively small difference in lipid content of the two corn sources.

Key Words: Corn, Energy, Growth

1309 Effect of rolling on ruminal *in situ* degradation of mature and immature whole-plant corn and stover silages. M. A. Bal¹, K. J. Shinnors¹, R. J. Straub¹, R. G. Koegel², and R. D. Shaver^{*1}, ¹University of Wisconsin and ²US Dairy Forage Research Center, USDA-ARS, Madison.

The objective of this experiment was to determine effects of mechanical rolling on 24-h ruminal *In situ* DM, NDF and starch degradation in mature or immature whole-plant (WP) corn and stover (ST) silages. Treatment silages were harvested with or without rolling using a self-propelled chopper. Treatment comparisons were in three separate *In situ* trials with two rumen fistulated Holstein cows. Twenty-five g DM samples were incubated in duplicate 25x35 cm dacron bags in each cow for each treatment comparison. In Trial 1, treatment silages and their DM contents were as follows: immature-unrolled ST (27.4%), immature-rolled ST (31.3%), mature-unrolled ST (42.5%), and mature-rolled ST (40.8%). Ruminal degradation of NDF was higher ($P < .01$) for immature-rolled ST than immature-unrolled ST (21.2 vs. 17.3%), but lower ($P < .05$) for mature-rolled ST compared to mature-unrolled ST (17.4 vs. 20.1%). In Trial 2, treatment corn silages and their DM contents were as follows: immature-unrolled WP (36.0%), immature-rolled WP (37.6%), mature-unrolled WP (53.2%), and mature-rolled WP (48.5%). Ruminal dry matter degradation was higher ($P < .01$) for rolled immature (67.1 vs. 58.1%) and mature (62.2 vs. 52.4%) WP corn silages. However, rolling did not affect ruminal NDF degradation in either immature (32.6 vs. 30.8%) or mature (25.1 vs. 21.5%) WP corn silages. In Trial 3, treatment corn silages and their DM contents were as follows: mature-unrolled and rolled WP corn silages from Trial 2 and rewetted-mature-unrolled WP (46.3%) and rewetted-mature-rolled WP (43.6%) corn silages. Rewetting mature WP corn silages did not affect ruminal DM or NDF degradation. Rolling increased ($P < .01$) ruminal starch degradation for both mature (82.1 vs. 47.7%) and rewetted-mature (76.8 vs. 45.3%) WP corn silages. Rolling improved ruminal degradation of corn silage, primarily through greater ruminal starch degradation.

Key Words: Corn Silage, Digestion, Starch

1310 Effect of mechanical processing on the utilization of whole-plant corn silage by lactating dairy cows. M. A. Bal^{1*}, R. D. Shaver¹, K. J. Shinnors¹, and L. D. Satter², ¹University of Wisconsin and ²US Dairy Forage Research Center, USDA-ARS, Madison.

Twenty-nine multiparous (47 DIM) and thirteen primiparous (52 DIM) Holstein cows were randomly assigned to either rolled or control whole-plant corn silage (CS) to evaluate effects of rolling on intake, digestion, and milk production. A 2-wk covariant adjustment period preceded a 16-wk experimental period. Diets containing 50% forage (2/3 corn silage:1/3 alfalfa silage) and 50% high moisture ear corn-roasted soybeans based concentrate (DM basis) were fed once daily in a TMR containing 17.5% CP. Whole-plant corn silages were harvested at the 1/2 milklime stage of kernel maturity with or without rolling using a self-propelled chopper. Theoretical length of cut was increased with the rolled silage to give similar mean particle length for the rolled (9.8 mm) and unrolled (9.9 mm) silages. Fractional kernel damage was 82 and 99% of the total recoverable kernel mass for control and rolled CS, respectively. Chemical composition was 62.7 vs. 62.5% moisture, 23.0 vs. 23.7% ADF and 38.2 vs. 39.4% NDF for control and rolled CS, respectively. Dry matter intake was not different between treatments averaging 26.6 and 21.9 kg/d for multiparous and primiparous cows, respectively. Milk yield was not different in multiparous cows (44.2 vs. 43.6 kg/d for control and rolled CS, respectively), but was higher for control CS ($P < .01$) in primiparous cows (37.5 vs. 35.4 kg/d for control and rolled CS, respectively). Milk fat percentage was not different in multiparous cows (3.66 vs. 3.76% for control and rolled CS, respectively), but was higher for rolled CS ($P < .05$) in primiparous cows (4.12 vs. 3.51%). Milk protein percentage tended ($P < .09$) to be higher for rolled CS (3.06%) compared to control CS (2.99%). Total tract starch digestibility tended ($P < .09$) to be higher for rolled CS than control CS (87.9 vs. 83.8%). Mechanical rolling of CS did not improve performance of lactating dairy cows, though starch digestibility was possibly improved. The small proportion of unbroken kernels in the control silage may have precluded a better response in this trial.

Key Words: Corn Silage, Milk Production, Starch

1311 Milk production and ruminal fermentation of grazing dairy cows supplemented with dry ground corn or steam-flaked corn. F. Bargo*, G. A. Pieroni, and D. H. Rearte, *Fac. Cs. Agrarias. UNMdP - EEA INTA Balcarce, Argentina.*

Twenty-eight Holstein cows (28 DIM, 537 kg BW) in a complete randomized design were used to study the effect of two corn grain processing methods on milk production and on ruminal fermentation. Treatments were: 5 kg/d dry ground corn (DGC) or steam-flaked corn (SFC). DGC and SFC had 8.5 and 8.7% CP; 16.3 and 23.7% NDF; 84.1 and 76.6% *in vitro* DM digestibility (IVDMD), respectively. All cows grazed an alfalfa (*Medicago sativa* L.) and orchardgrass (*Dactylis glomerata* L.) pasture with 2090 DM kg/ha availability, 16.9% CP, 47.5% NDF and 57.2% IVDMD for 8 wk. Both treatments received 0.5 kg/d sunflower meal and 2.5 kg/d corn silage plus 0.05 kg/d urea after each milking. Total DMI, estimated in six cows per treatment using Cr₂O₃ as a fecal marker, was not affected by treatments ($P > 0.05$). Milk yield and composition were similar among treatments ($P > 0.05$). BW change was not different among treatments ($P > 0.05$). Plasma urea N tended to be lower in SFC treatment ($P = 0.10$). Four Holstein cows ruminally cannulated were used in a cross over design to study ruminal fermentation and *in situ* DM degradation. Neither rumen fluid pH nor total VFA concentration was affected by treatments ($P > 0.05$), but SFC supplementation reduced NH₃-N concentration in rumen ($P < 0.05$). SFC presented a significantly higher soluble fraction, degradation rate and effective degradability of dry matter than DGC ($P < 0.05$). These results suggested that SFC supplementation to dairy cows grazing pasture improve ruminal DM digestion. However, effect of corn grain processing method on the yield of milk was small.

Item	DGC	SFC	SEM	$P <$
DMI, kg/d	17.65	16.41	1.49	0.58
Milk yield, kg/d	20.17	20.95	0.48	0.25
Fat, %	3.90	3.71	0.07	0.06
Protein, %	3.11	3.10	0.02	0.77
Lactose, %	4.76	4.87	0.05	0.12

1312 Extent of digestion of high lysine corn or regular corn as grain or silage in lactating Holsteins. S. D. Beek* and R. G. Dado, *Southern Illinois University, Carbondale.*

Previous *in vitro* studies showed that starch from several different high lysine (HL) corn hybrids was more digestible in the rumen than starch from regular (REG) corn hybrids. Objectives were to determine *in vivo* responses of cows fed HL corn as silage (CS) or grain (CG). Four ruminally cannulated cows were blocked in a 4x4 latin square and assigned to treatments in a 2x2 factorial design with main effects of CS or CG and levels of HL or REG. Periods were 21 d in length. Cows were dosed with chromic oxide (20 g/d) for 12 d. Rumen and fecal samples were taken every 15 hr for the last 5 d of each period. Diets contained 46% CS, 16% alfalfa silage, 17% CG, and 21% other ingredients (DM basis). Cows consuming diets containing HL CS had higher apparent DM digestibilities ($P < .05$), while cows consuming HL CG diets had lower DM digestibilities ($P < .03$). Apparent CP, NDF and ADF digestibilities, rumen pH and VFA concentrations did not differ across diets. Apparent starch digestibility was higher ($P < .04$) for diets containing HL CS and rumen NH₃ concentrations were lower ($P < .04$) for cows consuming HL CS and HL CG. This research indicates that animals consuming HL CS could benefit from higher DM and starch digestibilities and more efficient rumen NH₃ utilization.

	REG-CS	REG-CS	HL-CS	HL-CS	SEM	Contrast ($P > F$)		
	REG-CG	HL-CG	REG-CG	HL-CG		CS	CG	CS*CG
Digestibility,								
DM, %	67.5	58.8	71.2	66.9	1.6	.05	.03	.39
NDF, %	51.1	34.2	50.2	49.6	3.1	.30	.22	.25
Starch, %	87.1	83.7	89.0	91.7	1.4	.04	.87	.17
Kernals ¹	41.3	37.6	39.5	29.1	3.2	.36	.22	.54
NH ₃ , mg/dl	14.18	9.93	9.90	7.75	.82	.04	.04	.41

¹Number of kernals > 2 mm that passed in 100 g of feces (DM)

Key Words: High Lysine Corn, *In Vivo* Digestibility, Starch

1313 Evaluating the agronomic feasibility of planting late season corn. W. M. Cerkoney*, R. H. Pritchard, and Z. W. Wicks, III, *South Dakota State University, Brookings.*

The objective of this experiment was to screen corn varieties harvested as high moisture corn or ear corn for feeding value when the crop is grown under the stress of a shortened growing season. Corn varieties (n=20) of varying maturities were planted in late June. Whole shell corn (WSC) and ear corn (EC) were harvested and analyzed for DM, CP, NDF, ADF, starch, ether extract (EE) and ash content. Yield, kg/ha, and bulk density (BD) were quantified on WSC. Relative maturity (RELMAT) of varieties were expressed as actual growing degree units (GDU) divided by the total GDU required to reach maturity. The relationship of Yield and RELMAT on chemical composition was evaluated. There was an increase in Yield ($P < .05$), NDF ($P < .05$), EE ($P < .01$), and starch content ($P < .01$) of WSC as RELMAT increased. BD, CP, ADF, and ash content of WSC were not ($P > .10$) related to RELMAT. BD was positively correlated ($P < .01$) with Yield and starch content but not with CP, NDF, ADF, EE, and ash content. WSC was sorted into groups (G1 \bar{x} 1336 kg \pm 65, G2 \bar{x} 1048 kg \pm 26, and G3 \bar{x} 587 kg \pm 55) by natural separations in Yield. There were no differences ($P > .05$) between G1 and G2 in BD or starch content. The BD and starch content were greater ($P < .05$) for G1 and G2 than G3. There were no differences ($P > .10$) in CP, NDF, ADF, CP, and ash content between the Yield groups. Starch content of G1, G2, and G3 varieties were 79.61% \pm .44, 77.07% \pm .90, and 72.31% \pm 1.5, respectively. As Yield of ear corn increased, CP, NDF, ADF, and ash content decreased ($P < .01$), but starch ($P < .01$), DM ($P < .01$), and EE ($P < .05$) increased. The DM content of the ear corn at harvest was positively correlated with ($P < .05$) RELMAT. Greater Yield from corn varieties grown under stressful conditions were attributed to a higher starch content. Results of this study indicate earlier maturing corn varieties are more desirable when planting is delayed. BD primarily reflected RELMAT and starch content of grain but should not be used as the principle indicator of the feed value of corn.

Key Words: Stressed Corn, Feeding Value, Ear Corn

1314 Assessing the effectiveness of a novel source of processed non-structural carbohydrate (NSC) on rumen degradation of nutrients. J. Chiquette*, P. Lacasse, D. R. Ouellet, and D. Petitclerc, *Dairy and Swine R&D Centre, Lennoxville.*

The objective of this study was to evaluate a novel extrusion process to alter the site of digestion and increase the energy content of feed used in dairy cows. Four rumen fistulated cows were used. Nylon bags containing 20g (fresh weight) of either extruded or control feed (ground at 4.5mm) were incubated in triplicate for the following incubation times (h): 0, 1, 2, 4, 8, 12 and 48, for a total of 42 bags per cow. The extrusion of NSC increased ($P \leq 0.01$) the ruminal effective degradability of DM (from 61% to 74%, SEM = 0.6), starch (from 65% to 80%, SEM = 1.3) and protein (from 46% to 55%, SEM = 0.9). Small standard errors of the mean associated with each nutrient degradability reflect the high repeatability of results between animals. The extrusion process increased the availability of starch and protein at the rumen level for use by rumen microorganisms. This project was supported by R. Spratt, Ralston Purina Canada Inc.

Key Words: Extrusion Process, Ruminal Degradability, Dairy Cows

1315 Effects of proportions of steam-flaked corn and steam-flaked milo on performance and carcass characteristics and effects of switching grain sources during the finishing period on performance by finishing beef steers. G. C. Duff*¹, K. J. Malcolm-Callis¹, and M. L. Galyean², ¹Clayton Livestock Research Center, New Mexico State University, Clayton, ²Texas Tech University, Lubbock.

Two studies were conducted to determine the effects of proportions of steam-flaked corn (SFC) and steam-flaked milo (SFM) in the finishing diet on performance and carcass characteristics (Exp. 1) and effects of switching grain sources on d 56 of the finishing period on performance (Exp. 2). For Exp. 1, 180 medium-framed beef steers (British x Continental) were used. Treatments included (DM basis) 100% SFC:0% SFM (100:0), 75% SFC:25% SFM (75:25), 50% SFC:50% SFM (50:50), 25% SFC:75% SFM (25:75), and 0% SFC:100% SFM (0:100). No differences ($P < .10$) in ADG or daily DMI were observed among treatments; however, increasing the proportion of SFM increased ($P < .01$) the feed:gain ratio for the overall experiment. Increasing the proportion of SFM in the finishing diet resulted in a linear decrease ($P < .01$) in calculated NE_m , NE_g , and ME values of the diet. No major differences ($P > .10$) were noted among treatments for carcass characteristics. In Exp. 2, 144 medium-framed beef steers (British x Continental) were used. Treatments were SFC fed throughout the finishing period (CORN), SFC fed for 56-d followed by SFM for the remainder of the finishing period (SFC/SFM), SFM fed for 56-d followed by SFC for the remainder of the finishing period (SFM/SFC), and SFM fed throughout the finishing period (MILO). Steers fed CORN and MILO were the same steers used in Exp. 1 and fed 100:0 and 0:100, respectively. Average daily gain was decreased ($P < .10$) and feed:gain ratio was increased ($P < .05$) for the average of SFC/SFM and SFM/SFC vs CORN for the overall experiment. There were no differences noted in daily DMI among treatments for Exp. 2. Results suggest no benefit from mixing steam-flaked corn and steam-flaked milo in finishing diets, and switching grain sources during the finishing period may adversely affect performance.

Key Words: Beef Cattle, Performance, Grain Diets

1316 Effect of level of high moisture corn in alfalfa-based rations on starch digestion by mid lactation cows. B. P. Glenn*, T. E. Dawson, A. M. Lefcourt, and V. A. Wilkerson, USDA, Agricultural Research Service, Beltsville, MD.

Rumen fermentable starch from processed or high moisture grains has been shown to improve milk yield by lactating cows. Four Holstein cows (BW, 569 kg, SE 7; 160 DIM) were allotted to four dietary treatments in a 4 x 4 Latin square design. Diets were alfalfa-based TMRs, with 37 to 43% corn (DM basis), formulated to be isocaloric using NEL values for dry corn and high moisture corn determined previously with the Beltsville calorimeters. Corn was included at different ratios of dry ground corn (DC) to high moisture ground corn (HMC): 100% DC, 60:40 DC:HMC, 40:60 DC:HMC, or 100% HMC (R1, R2, R3, R4, respectively, and order to be used). Diets averaged 44% DM, 14% CP, and 36% NDF. Cows were fed ad libitum twice daily. Periods were 21 d with 14 d for adaptation and 5d total excreta collection. There was a significant effect (cubic, $P < .05$) on intake of DM (23.0, 20.0, 22.6, 21.6 kg/d) as HMC increased in the diet. Dry matter digestibility did not differ (66.1, 65.3, 66.9, 67.3%), but there was a linear ($P < .01$) increase in starch digestibility (87.9, 89.5, 90.1, 95.2%). Effect of diet on milk yield (actual) was similar to that for DMI (cubic, $P < .1$) (28.7, 26.9, 28.3, 27.4 kg/d). There was a significant effect (cubic, $P < .1$) on milk protein yield (.95, .90, .96, .91 kg/d) as HMC increased in the diet, as well as yield of all other milk components. The inclusion of corn, as a mixture of 40:60 DC:HMC, in alfalfa-based diets optimized starch digestibility, intake, milk yield, and milk protein yield.

Key Words: Starch, Degradability, Corn

1317 Effect of corn processing on milk production and dry matter intake of cows in early lactation. C. M. Luhman¹ and D. W. LaCount*², ¹Land O'Lakes and Cooperative Research Farm, Webster City, IA ²Land O'Lakes, Little Chute, WI.

Twenty-five multiparous Holstein cows were assigned to a replicated Uden Square design based on milk production and days in milk. Treatments started post-peak. Each cow received four of the five treatments which were: 1) pelleted complete feed (complete), 2) pelleted protein supplement plus fine ground corn meal (ground), 3) pelleted protein supplement plus cracked corn (cracked), 4) pelleted protein supplement plus steam flaked corn (steam flaked), and 5) pelleted protein supplement plus a blend of 45% fine ground corn meal and 55% steam-flaked corn (blend). Periods were three weeks in length and measures were taken the final week of each period. Rations were fed as a TMR and forage: concentrate was 46:54. Forage was 50:50 mix of corn silage and alfalfa haylage (DM basis). Dry matter intake was greater for cows fed complete than for cows fed steam flaked or blend ($P < 0.05$). Milk production was lower for cows fed cracked than for cows fed complete, steam flaked, or blend (41.1 kg vs. 43.8, 44.6, 43.7 kg, respectively; $P < 0.05$). Milk fat percent was highest for cows fed ground (3.5%) and lowest for cows fed steam flaked (3.21%; $P < 0.05$) with other treatments being intermediate. There were no differences in milk fat yield, milk crude protein percent, 3.5% FCM or 4.0% FCM; ($P > 0.05$), however, cows fed cracked yielded less milk protein ($P < 0.05$) than the other treatments. Milk urea nitrogen was highest for cows fed cracked and lowest for cows fed complete and steam flaked ($P < 0.05$). From an economic perspective, pelleted complete feed, fine ground corn meal, and steam flaked corn performed similarly (\$0.84, \$0.83, and \$0.81 improvement over cracked corn, respectively) based on milk production, components, and cost of feed and processing.

Key Words: Corn, Processing, Milk Production

1318 Influence of processing on the feeding value of barley for dairy cattle. A. Plascencia*¹, J. F. Calderon¹, E. J. DePeters², M. Lopez-Soto¹, M. Vega¹, and R. A. Zinn^{1,2}, ¹Instituto de Ciencias Veterinarias-UABC, Mexicali, México, ²University of California, Davis.

Three primiparous Holstein cows (135 d in milk, 589 kg) with ruminal and duodenal cannulas were used in a 3 x 4 Youden's square experiment. Four treatments were compared: 1) dry-rolled corn (density = .54 kg/L); 2) dry-rolled barley (DRB; density = .45 kg/L); 3) steam-flaked barley, medium flake (SFBM, density = .39 kg/L) and 4) steam-flaked barley, thin flake (SFBT; density = .26 kg/L). The basal diet contained (DM basis) 42.90% alfalfa hay, 39.86% grain, 9.98% cane molasses, 2.22% yellow grease, .62% sodium bicarbonate, and 4.42% protein-mineral supplement. Dry matter intake was not different ($P > .10$) for corn- versus barley-based. However, DMI was lower (4.9%; $P < .01$) for SFBT than for SFBM. Ruminal digestion of OM ($P < .05$), ADF ($P < .05$), and N ($P < .01$) were higher (17.9, 57.9, and 52.6%, respectively), and ruminal microbial efficiency and ruminal N efficiency were lower (34.3 and 23.0%, respectively; $P < .01$) for corn- than for barley-based diets. For the corn-based diet. Ruminal digestibility of OM and starch were lower (9.2 and 37.7%, respectively; $P < .05$) for DRB than for SFBM and SFBT. Ruminal digestibility of OM, starch, ADF, and feed N were lower (19.5, 49.1, 44.7, and 28.2%, respectively; $P < .05$) and ruminal N efficiency was greater (7.2%, $P < .05$) for SFBT than for SFBM. Total tract digestion of OM ($P < .01$), starch ($P < .05$), N ($P < .01$), DE ($P < .1$), and ME ($P < .01$) were lower (8.2, 14.4, 8.9, 8.0, and 11.9%, respectively), and total tract digestion of ADF was greater (20.3%, $P < .10$) for corn- than for barley-based diets. Total tract digestion of OM ($P < .10$), N ($P < .01$), DE ($P < .10$) and ME ($P < .10$) were greater (6.0, 4.1, 4.7, and 4.9%, respectively) for SFBM and SFBT than for DRB. Total tract digestion for OM, N, ADF, starch, DE, and ME were similar ($P > .10$) for SFBM and SFBT. Steam flaking increased the ME of barley by 13%. Flaking barley too thinly may have a detrimental effect on feed intake and nutrient digestion.

Key Words: Barley, Metabolism, Dairy Cattle

1319 Influence of cracked, gross grind or finely grind of corn on digestion and rumen function in steers fed a corn-based finishing diet. A. Plascencia¹, G. E. Arellano¹, J. F. Calderón¹, M. A. López-Soto*¹, and R. A. Zinn², ¹Instituto de Ciencias Veterinarias-UABC, Mexicali (México), ²University of California, Davis.

Four Holstein steers (136 kg) with cannulas in the rumen and proximal duodenum were used in a 4 x 4 Latin square experiment to evaluate the influence of corn processing on digestive function. Four dietary treatments were compared: 1) Steam-flaked corn (SFC, density = .30 kg/L); 2) dry-rolled corn - coarse (DRC-C, density = .55 kg/L); 3) dry rolled corn - medium (DRC-M, density = .50 kg/L) and 4) finely ground corn (FGC, density = .44 kg/L). The basal diet contained 73.25% corn and 9.8 % forage. Method of corn processing had no effect (P > .10) on ruminal pH, VFA or methane production. There were no treatment effects (P > .10) on ruminal digestion of feed N and ruminal microbial efficiency. Ruminal and total tract digestion of ADF was not affected (P > .10) by corn processing. Ruminal digestibility of OM and starch was greater (12.5 and 14%, respectively; P < .10) for SFC than for DRC-C, DRC-M, and FGC. Total-tract digestibilities of OM, starch, N, and DE were greater (6.1, 3.7, 8.2 and 7.3% respectively, P < .10) for SFC than for SFC than for DRC-C, DRC-M, and FGC. Total tract digestibility of starch tended to increase (linear component, P < .10) with degree of dry processing, although total tract digestibility of OM and GE was not improved (P > .10). Given that the DE value of SFC was 4.19 Mcal/kg, the DE values for DRC-C, DRC-M, and FGC were 3.97, 3.80, and 3.75 Mcal/kg, respectively. We conclude that the feeding value of dry-processed corn is not enhanced by reducing the particle size of the kernels beyond that obtained following coarse rolling.

Key Words: Corn, Metabolism, Cattle

1320 A comparison between the in situ bag procedure and three variations of the in vitro digestibility procedure using corn and sorghum. E. A. Reed* and R. L. Belyea, University of Missouri, Columbia.

The in situ polyester bag technique and the static in vitro culture procedure are two common laboratory methods used to estimate the digestibility of feedstuffs. Direct comparisons between these methods are lacking. The objectives were to compare the dry matter and nitrogen disappearance of corn and sorghum grain using the in situ bag procedure versus three variations of static in vitro cultures. For the in situ procedure, samples of corn and sorghum were placed into the rumen of a lactating dairy cow for removal at 0, 6, 12, and 24 hours. At zero hours, inoculum was obtained for in vitro cultures for simultaneous fermentation. The three in vitro variations were as follows: (I) feed placed into an in situ bag and incubated in a flask (II) feed placed directly into flask, incubated and filtered through 52 um Pecap polyester under vacuum and manually washed (III) feed placed directly into flask, incubated and filtered through 52 um Pecap polyester under vacuum only. For the in vitro III method, it was not possible to adequately rinse feed residues and data were not used. Disappearance of DM and N was low in the in vitro I method versus the other methods due to films that formed on the dacron bags. Within corn, DMD was greater (P < .05) at 0, 6 and 12 hours for in vitro II versus the in situ (37.0, 66.3 and 86.8 versus 25.5, 56.7 and 77.5 %, respectively). Nitrogen disappearance (ND) was greater (P < .05) at 0, 6 and 12 hours for in vitro II versus the in situ (32.1, 54.8 and 79.5 versus 20.9, 46.4 and 60.1 %, respectively). In situ and in vitro II DMD and ND were similar at 24 hours. Within sorghum, DMD was greater (P < .05) at 6 and 12 hours for in vitro II versus the in situ (36.5 and 47.1 versus 30.1 and 55.7 %, respectively). ND was similar between in situ and in vitro II at each hour. The in situ and in vitro II methods provided similar 24 hour DMD and ND estimates. DMD and ND estimates varied at shorter incubation lengths. Relative differences between grains were similar regardless of method.

1321 Effects of moisture level and particle size of corn grain on nutrient utilization and milk production of lactating dairy cows. R. B. Reis*, F. San Emeterio, W. E. Campos, and L. D. Satter, USDFRC, USDA-ARS and Dairy Science Dept., Univ. of Wisconsin, Madison.

The objective was to evaluate the effect of corn source on nutrient use, milk yield and ruminal fermentation. Twelve rumen fistulated cows were arranged in two 6 x 6 Latin squares with 21 d periods. Treatments were dry shelled corn (DSC), high moisture shelled corn (HMSC) or high moisture ear corn (HMEC) that were coarsely ground (CG dgw 3.83mm) or finely ground (FG dgw 1.15mm). TMR contained 46% forage and 54% concentrate and were fed once (1x) or twice (2x) daily according to the square. Orthogonal contrasts compared moisture level, presence of cob and fineness of grind. Ruminal NH₃ and Ac:Pr ratio were decreased and total VFA and starch digestibility were increased (P < .05) by corn moisture and fine grinding with both 1x and 2x. Absence of cob increased milk protein contents and reduced MUN (P < .05) in cows fed 1x. Moisture, fine grind and absence of cob improved milk yield (P < .05) when cows were fed 2x.

	DM	Starch	Milk	Fat	Protein	MUN	pH	NH ₃	TVFA
	Dig. %	Dig. %	kg/d	kg/d	kg/d	mM		mM	mM
DSC-CG	1X 62.6 ^c	80.4 ^c	36.2	1.35 ^a	1.06	15.5	6.12 ^a	10.2 ^a	123 ^{ac}
	2X 65.6	82.1 ¹	36.3 ¹	1.44	1.11 ¹	15.3 ¹	5.99 ¹	10.9 ¹	128 ¹
DSC-FG	1X 69.2 ^{bc}	88.1 ^{abcd}	36.9	1.27 ^b	1.11	13.8	6.09 ^a	9.3 ^b	125 ^{abc}
	2X 65.9	86.5 ¹²	37.4 ²	1.41	1.17 ¹²³	14.7 ¹²	5.98 ¹	10.1 ²	132 ¹²
HMEC-CG	1X 64.3 ^{cd}	85.2 ^{cde}	33.2	1.26 ^{bd}	1.02	15.4	6.10 ^a	8.74 ^b	123 ^a
	2X 69.6	82.1 ¹	38.2 ³	1.44	1.19 ¹⁴	14.6 ¹³	5.94 ¹	8.88 ³	133 ²
HMEC-FG	1X 67.9 ^{ce}	90.2 ^{abce}	34.7	1.17 ^c	1.03	14.9	5.99 ^b	6.79 ^c	127 ^{ac}
	2X 65.1	89.2 ²³	39.4	1.49	1.22 ²⁴	14.5 ¹⁴	5.81	7.53	136 ²³
HMSC-CG	1X 67.4 ^{cf}	84.9 ^{cde}	37.1	1.27 ^b	1.11	12.9	5.96 ^{bc}	7.44 ^c	128 ^c
	2X 67.1	87.3 ¹³⁴	39.5	1.48	1.25 ⁴⁵	14.3 ¹⁵	5.80	8.5 ³	135 ²
HMSC-FG	1X 70.9 ^{def}	92.6 ^a	36.1	1.18 ^c	1.11	12.7	5.94 ^c	6.98 ^c	130 ^{bc}
	2X 70.1	91.9 ²⁴	40.6 ⁴	1.41	1.26 ²⁴	13.6 ²³⁴⁵	5.80	7.04	140 ³
SEM	1X 1.27	1.12	0.92	0.01	0.02	0.55	0.02	0.25	1.8
	2X 2.58	1.02	0.07	0.05	0.02	0.24	0.02	0.29	1.58

a,b,c,d,e,f and 1,2,3,4,5 Means in the same column and frequency of feeding (1x or 2x) with different superscripts differ (P < .05)

Key Words: Corn, Particle Size, Rumen

1322 The effects of extrusion on different types of feedstuffs. C. R. Richardson¹, L. L. Barnham¹, K. J. Sanders¹, B. S. Clyburn*¹, and N. Said², ¹Texas Tech University, Lubbock and ²Insta Pro International, Des Moines, IA.

Laboratory analyses were conducted to determine the digestibility of two types of oil seed that were obtained from a commercial producer. Treatments included: raw soybeans (RS), soybean meal 47% (SBM), extruded soybeans at 154°C (EB154), extruded soybeans at 160°C (EB160), extruded soybeans with Larex at 160°C (EBL), Soy plus (SP), raw cottonseed (CS), cottonseed meal 41% (CSM), extruded cottonseed at 160°C (ECS) and extruded expelled cottonseed at 154°C (EEC). Dry matter disappearance (DMD) was determined by the Moore modification of the Tilley and Terry procedure (1970). Fermentation media was incubated for 4, 8, 16 and 24 h. When comparing within oilseed types SBM and EEC had the highest DMD (P < .05) for all times. Treatment EB160 had the lowest DMD for all times, however no differences were detected between EB160 and CS. When comparing temperatures on the extruded soybean products, no differences were found for DMD across incubation times. A higher DMD (P < .05) was detected for SBM compared to CSM across incubation times. In addition RS was higher (P < .05) in DMD than CS across all incubation times. At 4h, DMD for SP (36.9%) was lower (P < .05) than RS, SBM, and EB154 (47.0, 51.0, 44.1%, respectively). There was a difference in DMD for CSM compared to CS and ECS. After 8h, DMD for RS (50.3%) was higher than EB, EBL, and SP (43.0, 43.4, and 43.3%, respectively). Differences were detected between CSM, CS, and ECS (42.5, 28.6, and 24.0% respectively). After 16h, there was a no difference (P > .05) with the exception of SBM which was the highest. Differences were found among CSM, CS, and ESC for DMD (50.9, 35.6, and 32.1%, respectively). At 24h, there was a difference (P < .05) between SP and EB160 (65.8 and 59.2%, respectively). Differences (P < .05) between CSM, CS, and ECS was detected at 24h (48.7, 35.1, and 34.8%, respectively). These data suggest that processing methods may not improve digestibility over soybean meal, however processing may increase digestibility for whole cottonseed.

Key Words: Soybean, Cottonseed, Extrusion

1323 The effect of geographical location of corn hybrid on processing time, kwh electricity used, and flake quality. G. B. Salyer¹, C. R. Richardson¹, G. V. Pollard*¹, and S. D. Soderlund², ¹Texas Tech University, Lubbock and ²Pioneer Hi-Bred International Inc., Des Moines, IA.

Genetics and environmental factors are primarily responsible for influencing composition of grains grown in differing locations and conditions. Steam flaking is a common method used to increase feeding value of corn for feedlot cattle, which requires energy inputs and disruption of the grain kernel. Four Pioneer[®] brand corn hybrids grown in four geographic locations were used to determine time required to flake 22.7 kg of conditioned, steamed grain, electrical energy consumption, flake durability, and percent fines. Locations consisted of Hall county Nebraska, Parmer county Texas, Morton county Kansas and Ford county Kansas. Effects due to hybrid, location and possible interactions were investigated. All grains were tempered for 18 h and adjusted to an internal moisture of 18.5% using water and wetting agent. Exactly 22.7 kg of grain was steamed for 30 min and flaked utilizing a small-scale steam-flaker. Three replications of each hybrid represented at each location were flaked to a consistent density of .36kg/l (28 lb/bu). Electrical energy consumption was measured using a multi-function power systems monitor. Location had a significant ($P < .05$) effect on electrical energy consumption. The kwh of electricity ranged from .290 to .597 and hybrids grown at Morton county Kansas and Ford county Kansas required more ($P < .05$) electrical energy to process. Hybrid nor location had any effect ($P > .05$) on processing time. However both hybrid and location effected ($P < .05$) flake durability and percent fines. Flake durability ranged from 83.90 to 90.30 percent and supports the results found for percent fines. Fines percentage ranged from 2.42 to 4.75 percent. These data suggest that processing of different corn hybrids grown at different locations may influence the quality of flakes produced by affecting flake durability and percent fines, and energy consumption during the flaking process.

Key Words: Steam Flaking, Corn Hybrid, Processing

1324 The effect of geographic location of corn hybrid on crude protein, ether extract, total starch and starch availability. G. B. Salyer*¹, C. R. Richardson¹, and S. D. Soderlund², ¹Texas Tech University, Lubbock and ²Pioneer Hi-Bred International Inc., Des Moines, IA.

Four Pioneer[®] brand corn hybrids grown in four geographic locations were used to determine how hybrid, location and processing effect CP, ether extract (EE), total starch (TS), and enzyme susceptible starch (ESS). Locations were identified as A, B, C, D and hybrids were identified as number 1 through number 4. Hybrid, location and processing were found to effect ($P < .05$) CP content. Location D had the highest CP content for processed (P) and unprocessed (U) grain (8.33 and 8.51 % respectively). Hybrid 4 was higher ($P < .05$) in CP content (8.09 %) for U grain. Hybrids 2, 3 and 4 (7.90, 7.99, and 7.94 % respectively) were higher ($P < .05$) in CP content for P grain. Location and hybrid affected ($P < .05$) EE content of grain but processing did not effect ($P > .05$) EE content. Hybrid 4 had a higher ($P < .05$) EE content for both P and U grain (4.29 and 4.26 % respectively). No differences ($P > .05$) among hybrids in TS content of U grain were detected. However differences ($P < .05$) among locations were found. Location A (76.66 %) had the highest ($P < .05$) TS content of U grain and was different from locations C and D (74.54 and 73.67 % respectively). No differences ($P > .05$) among locations in TS content for P grain were found however differences ($P < .05$) among hybrids were found. Hybrid 3 (72.09 %) had the highest TS content for P grain and was higher ($P < .05$) than hybrids 1 and 2 (68.22 and 69.59 %). Enzyme susceptible starch was affected ($P < .05$) by hybrid, location and processing. Enzyme susceptible starch for U grain ranged from 50.68 % (hybrid 3) to 52.72 % (hybrid 1). The P hybrid 4 had the highest ESS (86.17 %) and was higher ($P < .05$) than hybrids 1, 2 and 3 (82.81, 81.42 and 81.52 % respectively). Location C had the highest ESS content for both P (84.83 %) and U (53.88 %) grain and was higher ($P < .05$) than location D for P (81.22) and U (48.83) grain. These data clearly indicate that both location and hybrid effect the composition of corn used in the study.

Key Words: Steam-Flaking, Corn Hybrids, Nutrient Composition

1325 Effects of moisture level and particle size of corn grain on milk production, milk composition and dry matter intake of lactating dairy cows. F. San Emeterio*, R. B. Reis, W. E. Campos, and L. D. Satter, USDFRC, USDA-ARS and Dairy Science Dept., Univ. of Wisconsin, Madison.

Objectives of this study were to compare dry matter intake and milk production of cows fed once (1X) or twice (2X) daily. Thirty-six cows were utilized in three 6 X 6 Latin squares for each feeding frequency. Periods were 21 days and treatments were either dry shelled corn (DSC), high moisture shelled corn (HMSC) or high moisture ear corn (HMEC) that were coarsely ground (CG dgw 3.83mm) or finely ground (FG dgw 1.15mm). The TMR contained 46% forage and 54% concentrate. Orthogonal contrasts were made comparing moisture level of corn, presence of cob and fineness of grind. Results are shown below.

		DMI	Milk	FCM	Fat	Protein	MUN
		kg/d	kg/d	kg/d	kg/d	kg/d	mM
DSC-CG	1X	25.5	37.7	35.3	1.35	1.13 ^{ad}	15.8 ^a
	2X	24.9	37.2	36.4	1.44	1.15 ¹	16.0
DSC-FG	1X	24.5	37.2	34.8	1.33	1.13 ^{ad}	14.5
	2X	25.2 ¹	38.9	37.1	1.43	1.20	14.6
HMEC-CG	1X	23.5	37.9	32.1	1.21	1.06 ^{bc}	15.6
	2X	24.3	38.0	36.7	1.43	1.14	14.9
HMEC-FG	1X	23.6	36.3	32.5	1.20	1.07 ^b	15.5
	2X	24.2	37.7	36.0	1.39	1.16	14.7
HMSC-CG	1X	24.3	38.0	34.8	1.31	1.14 ^d	14.2
	2X	24.2	39.3	36.8	1.40	1.21	14.4
HMSD-FG	1X	24.3	36.2	32.2	1.18	1.13 ^d	12.9 ^b
	2X	24.1 ²	40.3	36.1	1.33	1.23 ²	13.1 ¹
SEM	1X	0.44	1.09	1.09	0.05	0.01	0.47
	2X	0.19	0.73	0.05	0.02	0.01	0.45

^{a,b,c,d} and ^{1,2} Means in the same column and frequency of feeding (1X or 2X) with different superscripts differ ($P < .05$)

Key Words: Corn, Particle Size, Milk

1326 Altering protein degradability and storage form of wet corn gluten feed in diets of lactating dairy cows. J. W. Schroeder* and C. S. Park, North Dakota State University.

Twenty-four primiparous and multiparous Holstein cows averaging 560 kg BW and 56 d in lactation were stratified by age, DIM, and milk yield, and assigned to treatments arranged in a completely randomized design. Treatments compared the substitution of fresh versus long-term stored (silo bag for 6 mo) wet corn gluten feed (WCGF) and graded levels of dietary undegraded intake protein (UIP) for 10 wk in Calon gates with diets containing 19% DM WCGF. Four isocaloric (1.72 Mcal NE_L) and nearly isonitrogenous (17.2% CP) treatments included (WCGF storage form/% dietary UIP level): fresh/5.4; stored/5.4; stored/6.3; and stored/7.2. UIP level was adjusted using soybean meal, corn gluten meal, and blood meal. Substituting fresh with stored WCGF (5.4% UIP) did not alter milk yield, milk composition, DMI, or body condition. Only ruminal ammonia was higher ($P < .05$) for cows fed stored WCGF. Treatments containing stored WCGF with 6.3 and 7.2% UIP had higher ($P < .05$) ruminal ammonia concentrations and serum levels of urea nitrogen and insulin. Adding UIP elevated ($P < .05$) casein, fat, and total solids in milk, while milk yield remained unchanged. WCGF stored in an oxygen-limiting environment neither altered overall lactational response nor feed palatability. Also, no difference in production measures were found between 6.3 and 7.2% UIP treatments.

Key Words: Wet Corn Gluten Feed, Extended Storage, Protein Degradability

1327 *In situ* disappearance of dry matter, fiber, protein and starch as affected by the tempering and roasting of Idagold barley. S. J. Sorensen* and D. D. Hinman, *University of Idaho, Caldwell.*

Previous studies have shown that different methods of processing barley affect digestibility. Roasting barley produces a complex of protein and simple sugars (measured by ADIN levels) which may slow ruminal starch digestion, but not total tract digestibility. Idagold barley was processed one of four ways to determine the effect *in situ* on DM, CP, ADF and starch disappearance. Treatments were: dry rolled (DR); temper then rolled (TR); temper, roasted then rolled (RSTROLL); or temper, rolled then roasted (ROLLRST). Whole barley was roasted at 177°C for 10 min to obtain desired ADIN level (.4%). Each treatment was incubated in each of four ruminally cannulated steers, with bags removed after 1, 2, 4, 6, 12, 24 and 48 h of incubation. Dry matter disappearance rate was slower ($P < .05$) for ROLLRST than DR or RSTROLL but similar to the TR DMD rate. Extent of dry matter disappearance was greater ($P < .05$) for DR than TR and ROLLRST at all collection hours and similar ($P > .05$) to RSTROLL at 1, 2, and 6 h. Crude protein levels were lower ($P < .05$) at 1, 2, 4, 6, and 12 h for DR than TR, ROLLRST and RSTROLL. At 48 h, ROLLRST had the most remaining CP of all treatments ($P < .05$). After 48 h of incubation ROLLRST had the highest ($P < .05$) percentage (81%) of ADIN remaining. Acid detergent fiber followed the same pattern as ADIN with ROLLRST having the most (92%) remaining at 48 h ($P < .05$). Starch disappearance rate was faster ($P < .05$) for TR than the other treatments. Temper rolled starch levels were higher ($P < .05$) than DR, RSTROLL and ROLLRST for all collection hours except 1 h. Temper rolled starch levels remained fairly constant and higher than all other treatments ($P < .05$) until 6 h when starch decreased rapidly until 24 h then leveled off for the remaining time which gave TR a faster starch disappearance rate. Barley that was temper, roasted and rolled had a more constant rate of starch disappearance over the 48-h incubation period. This may translate into lower incidence of acidosis in cattle consuming high grain diets.

Key Words: Barley, Processing, Starch

1328 Effects of corn processing on ruminal measurements of prepartum and early postpartum dairy cattle. G. A. Varga*, H. M. Dann, D. E. Putnam, and L. C. Griel, Jr., *The Pennsylvania State University, University Park.*

Experiments were conducted to assess the effects of feeding cracked corn (C) or steam flaked corn (F) to prepartum and postpartum cows. In the prepartum period, seven multiparous ruminally cannulated Holstein cows, ranging from 9 to 17 d prepartum, were assigned to treatment: C (n=3) or F (n=4). In the postpartum period, six multiparous ruminally cannulated Holstein cows, ranging from 23 to 39 d postpartum, were assigned to treatment: C (n=3) or F (n=3). Other than corn source, diets were identical in ingredients. Corn was 21% and 24% of the prepartum and postpartum rations, respectively, on a dry matter basis. The prepartum TMR had a forage:concentrate of 64:36, 1.6 Mcal/kg NE_L and 13.2% crude protein (CP) on a dry matter basis. The postpartum TMR had a forage:concentrate of 50:50, 1.62 Mcal/kg NE_L and 16.3% CP. Cows were housed in a tiestall barn, had continuous access to water and were fed once daily for ad libitum intake. The prepartum and postpartum sample periods were 5 days. Ruminal pH and ammonia-N measurements were collected at 0, 1.5, 3.5, 5.5, 8.5, 11.5, 14.5, 18, 21.5, and 24.5 hours relative to feeding. Fecal samples were collected at 0, 6, 12, 18, 24.5, 31, 37, 44, 50, 58, 64, 70, 76, 78, 84, 90, 96, and 102 hours relative to initial feeding. Chromic oxide was used to estimate apparent digestibility. Prepartum ruminal pH (6.7), ammonia-N (2.8 mg/dl), dry matter digestibility (59.7%), and crude protein digestibility (54.9%) were unaffected ($P > .05$) by corn source. Postpartum ruminal pH (6.4), ammonia-N (9.8 mg/dl), dry matter digestibility (60.8%), and crude protein digestibility (59.2%) were unaffected ($P > .05$) by treatment. In the present study, corn processing did not appear to affect ruminal measurements of late gestation or early lactation dairy cows.

Key Words: Transition Cow, Corn Processing, Ruminal Fermentation

1329 Effects of fineness of grinding and conservation method of corn grain on ruminal and whole tract digestibility and ruminal microbial protein production of pregnant Holstein heifers. Y. Ying, M. S. Allen, M. J. VandeHaar, and N. K. Ames*, *Michigan State University, East Lansing.*

The effects of fineness of grinding and conservation method of corn grain on ruminal and whole tract digestibility, and ruminal microbial protein production of pregnant Holstein heifers were examined using 8 ruminally and duodenally cannulated heifers in a duplicated 4 x 4 Latin square design with 21-d periods. Corn treatments were dry corn, ground finely or coarsely (mean particle size 771 μm or 4524 μm), and high moisture corn, ground finely or coarsely (mean particle size 1933 μm or 5526 μm), prior to feeding. Diets contained 62% alfalfa silage and 36% corn grain. High moisture conservation method and fine grinding increased ruminal digestibility of starch and OM, but only fine grinding increased total tract digestibility of starch. High moisture conservation tended to reduce microbial protein production per kg of OM fermented but only decreased microbial yield when coarsely ground. High moisture conservation tended to increase ruminal VFA concentration and decreased mean ruminal pH. Treatments did not alter DMI. Although both conservation method and fine grinding had large effects on ruminal starch digestibility, only high moisture conservation decreased ruminal pH and microbial efficiency for pregnant heifers.

	DF	Treatment				P value		
		DC	MF	MC	C	G	CxG	
DMI, kg/d	7.6	7.9	7.6	7.7	NS	NS	NS	
RDS, %	56.7	41.7	81.4	52.7	<0.01	<0.01	NS	
TTDS, %	96.2	94.7	96.3	94.7	NS	<0.01	NS	
RDOM, %	39.7	35.0	52.5	39.6	<0.01	<0.01	NS	
TTDOM, %	75.8	76.1	76.1	76.3	NS	NS	NS	
MNY, g/d	101.9	104.1	108.0	89.7	NS	NS	0.05	
MNE, g/kg of OMTD	23.7	26.4	21.4	21.7	0.08	NS	NS	
pH	6.70	6.63	6.57	6.57	0.03	NS	NS	
Total VFA, mM	62.3	61.5	66.4	63.8	0.06	NS	NS	

DF:dry fine, DC:dry coarse, MF:high moisture fine, MC:high moisture coarse
 C:Effect of conservation method, G:Effect of fineness of grinding, CxG:Interaction of C and G
 RDS:Ruminal degraded starch, TTDS:Total tract degraded starch, RDOM:Apparent ruminal degraded OM, TTDOM:Total tract degraded OM, MNY:Microbial N yield, MNE:Microbial N efficiency, OMTD:OM truly digested in the rumen

Key Words: Corn Processing, Starch Digestibility, Microbial Protein

1330 Effects of fineness of grinding and conservation method of corn grain on ruminal and whole tract digestibility and ruminal microbial protein production of Holstein cows in early lactation. Y. Ying, M. S. Allen, M. J. VandeHaar*, and N. K. Ames, *Michigan State University, East Lansing.*

The effects of fineness of grinding and conservation method of corn grain on ruminal and whole tract digestibility, and ruminal microbial protein production of Holstein cows were examined using 8 ruminally and duodenally cannulated primiparous cows (beginning at 39 ± 11 DIM) in a duplicated 4 x 4 Latin square design. Corn treatments were dry corn, ground finely or coarsely, and high moisture corn, ground finely or coarsely, prior to feeding. Diets contained 49% alfalfa silage and 38% corn grain. High moisture conservation and fine grinding increased ruminal digestibility of starch and OM but only high moisture corn decreased mean ruminal pH. Total tract digestibility of OM was increased by fine grinding and high moisture conservation, and total tract digestibility of starch was increased by fine grinding and tended to be increased by high moisture conservation. Treatments did not alter DMI. Fine grinding increased FCM and milk protein percentage and high moisture corn tended to decrease FCM. Fine grinding decreased microbial N efficiency and microbial N yield was not affected by treatment. Fine grinding seems more beneficial for FCM production than high moisture conservation for early lactation dairy cows.

	DF	Treatment				P value		
		DC	MF	MC	C	G	CxG	
DMI, kg/d	15.6	14.8	14.4	14.7	NS	NS	NS	
RDS, %	63.2	36.8	76.3	47.8	<0.01	<0.01	NS	
TTDS, %	95.7	91.8	96.8	92.9	0.09	<0.01	NS	
RDOM, %	59.5	44.3	62.3	51.0	0.02	<0.01	NS	
TTDOM, %	82.0	80.4	82.8	81.7	<0.01	<0.01	NS	
MNY, g/d	150.0	159.0	140.1	153.2	NS	NS	NS	
MNE, g/kg of OMTD	15.0	19.2	14.5	17.3	NS	<0.01	NS	
pH	6.23	6.43	6.07	6.07	<0.01	NS	NS	
3.5% FCM, kg/d	29.9	27.5	27.9	27.2	0.10	0.04	NS	

DF:dry fine, DC:dry coarse, MF:high moisture fine, MC:high moisture coarse
 C:Effect of conservation method, G:Effect of fineness of grinding, CxG:Interaction of C and G
 RDS:Ruminal degraded starch, TTDS:Total tract degraded starch, RDOM:Apparent ruminal degraded OM, TTDOM:Total tract degraded OM, MNY:Microbial N yield, MNE:Microbial N efficiency, OMTD:OM truly digested in the rumen

Key Words: corn processing, starch digestibility, microbial protein

1331 Effect of concentrate level and sugarcane bagasse hydrolysis on growth and body composition of Zebu heifers. D. P. D. Lanna^{1*}, J. P. Morais¹, C. Boin¹, P. R. Leme², F. B. Castro², and D. G. Fox³, ¹ESALQ/Univ. São Paulo, Brazil, ²Instituto de Zootecnia, ³Cornell University, Ithaca.

This work evaluated growth rate, feed efficiency and body composition of 36 zebu heifers randomized to blocks in a 2x2 factorial arrangement. Dietary treatments were: 1) sugarcane bagasse hydrolyzed at 17 kgf/cm² of steam-pressure (HSCB) with or without rapid decompression (explosion) at the end of treatment; 2) concentrate levels of 25 and 45% of the DM. Performance and body composition were evaluated in a 112-day feedlot trial. No interactions were found and thus comparisons are for main effects of steam-pressure treatment and concentrate level. Results demonstrated omission of rapid decompression increased daily gain (0.67 and 0.76 kg/d; P<.05) and feed intake (5.8 to 6.7 kd/d; P<.05). Higher levels of concentrate also increased daily gain (0.66 and 0.76 kg/d; P<.05) and feed intake (5.7 to 6.8 kg/d; P<.05). The parallel increases in DLWG and DMI resulted in no difference in feed conversion efficiency 8.7; 8.9; 8.5 e 9.0 kgDMI/kgLWG for treatments with or without rapid decompression and for 25 or 45% concentrate level. Body composition was estimated using deuterium dilution techniques and equations developed for zebu animals. Treatments did not alter body composition or composition of gain. Final lipid content were 15.9, 14.9, 14.7 and 16.1 %EBW for treatments with and without rapid decompression and 25 or 45% concentrate. Estimated rates of lipid deposition were higher between treatments without and with rapid decompression (216 x 175 g/d; P<.10) and between treatments with 45 and 25% concentrate level (225 x 166 g/d; P<.10). Rapid decompression after hydrolysis is widely recommended although costly due to losses of energy in the steam. These data indicate that large savings could be obtained by omitting post-hydrolysis rapid decompression. At high levels of HSCB intake (2.9% BW) zebu heifers do not respond to increasing concentrate levels, in agreement with other data with zebu.

Key Words: Body Composition, Sugarcane Bagasse, Zebu

1332 Ruminal degradation of dry matter, fiber and pectins of byproducts and cereal grains. M. Chahine*, S. Cal-samiglia, A. Ferret, and J. Gasa, *Universitat Autònoma de Barcelona, 08193-Bellaterra, Spain.*

Two ruminally cannulated heifers were used to study in situ ruminal degradation profile of dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and pectins of corn gluten feed (CGF), brewers grains (BG), beet pulp (BP), citrus pulp (CtP), soyhulls (SH), oats (O), barley (Br), wheat (W), corn (C) and sorghum (S). Heifers were fed a forage-based diet (FOR) or a concentrate-based diet (CON). Dacron bags filled with 6 g of sample were incubated for 2, 4, 8, 16, 24, 48 and 72 h in the rumen. The zero hour was estimated as the soluble fraction. Data were used to calculate solubility (a), potentially degradable fraction (b), rate of degradation (Kd), lag time (L) and ruminal degradation (Deg). Byproduct DM solubility ranged from 7.4 (CtP in FOR) to 42.8 % (CGF in CON) and Kd from .017/h (CtP in CON) to .045/h (CGF in CON). Ruminal DM degradation of byproducts ranged from 22.3 (BP in both diets) to 54.5 % (CGF in CON). There were no differences in a, L or Deg of NDF among byproducts. In CON, Kd was higher in CGF (.053/h) compared with CtP (.011/h). Only NDF degradation from BP was lower in CON (7.6%) compared with FOR (15.7%). There was no difference in b, and L of ADF among byproducts. The ADF degradation was highest (P < .05) for CtP (16.5%) and lowest (P < .05) for BG (1.7%) in FOR. The ADF degradation was lower (P < .05) in CON compared to FOR for BP (.5 vs 7.4 %) and SH (1.1 vs 6.9 %). There were no differences in b, Kd, L and Deg of pectin between BP and CtP. Incubation of CtP in CON reduced (P < .05) the value of b (94.7 vs 66.1 %) and Kd (.048 vs .024 /h) without affecting degradability. Dry matter solubility of cereals ranged from 19.9 (S in FOR) to 57.1 % (O in CON). Rates of DM degradation of cereals were highest (P < .05) for W in CON (.365/h) and lowest (P < .05) for O and S in FOR (.013/h). Only S had a L (6 and 13.5 h for FOR and CON, respectively). Degradation was highest (P < .05) in W in CON (79.9%) and lowest (P < .05) in S in FOR (25.3%).

Key Words: Rumen Degradation, Fiber, Concentrates

1333 Protein digestibility of chickpeas, navy beans and safflower meal in diets for sheep fed finishing diets. J. E. Dominguez* and R. Barajas, *EMVZ/Universidad Autónoma de Sinaloa Culiacan, Sinaloa (Mexico).*

To determinate the true digestibility value of crude protein of chickpeas, navy beans and safflower meal, four St. Croix lambs (14.75 Kg of BW) were used in a Yuden 4 x 5 latin square design experiment. The diets in that consisting the treatments were: 1) Diet 15% of alfalfa hay and 85% concentrate with 17% of CP and 3.44 Mcal DE/Kg, containing 25% of canola meal; the treatments 2, 3, 4 and 5 consisted in a substitution of canola meal using chickpeas, cooked navy beans, safflower meal and tapioca meal, respectively. Canola meal and tapioca meal treatments were used as positive and negative control, respectively. Safflower meal inclusion, diminished (P<.05) in 10.6 and 12.2% the total tract OM digestion and DE content of the diet. The other treatments there were not effect (P>.10) on total tract OM digestion and DE content of the diet. The tapioca meal diet reduced (P>.05) in 15% the total tract CP digestibility of the diet. Using as reference value the 88% and 3% of true CP digestibility of canola meal and tapioca meal respectively, the true digestibility of CP of chickpeas, navy beans and safflower meal were 85, 80 and 84%, respectively.

It is concluded that chickpeas, cooked navy beans and safflower meal there are good sources of CP by sheep, but is needed be careful when safflower meal is used because reduce the energy content of the diet.

Key Words: Protein, Digestibility, Sheep

1334 Substitution of starch for pectin in high concentrate beef cattle diets: feedlot performance and carcass characteristics. W. Henrique¹, P. R. Leme^{1*}, D. P. D. Lanna², G. F. Alleoni¹, and J. L. V. Coutinho Filho¹, ¹Instituto de Zootecnia, SP, Brazil, ²ESALQ/Univ. São Paulo, SP, Brazil.

There is controversy on the energy value of pectin sources for ruminants fed different nonstructural carbohydrate proportions. The objective of this experiment was to evaluate the substitution of cracked corn by dehydrated citrus pulp pellets (DCP) as starch and pectin sources, respectively. Diets had 0, 25, 40 and 55% DCP and 20% corn silage, all on a dry matter basis and were fed individually to 28 Santa Gertrudis young bulls with an average initial weight of 290 kg and 9 months of age. The experiment lasted 92 days after a 28 days of adaptation period. Results are on the table below. There were no effects of the treatments on daily weight gain, dry matter intake, dry matter intake as a percentage of live weight and feed efficiency. Linear or quadratic regressions were not significant (P>0.10) for performance variables and carcass characteristics studied. Empty body composition, estimated by 9-10-11th rib cut analysis was similar for all treatments (P>0.10). There were no differences on corn and DCP metabolizable energy content. Results of this trial confirm other data indicating that energy content of citrus pulp is currently underestimated by feeding tables.

Item	0% DCP	25% DCP	40% DCP	55% DCP
Initial weight, kg	299	306	314	312
Final weight, kg	440	453	450	455
Live wt. gain, kg/d	1.534	1.592	1.480	1.554
Feed intake, kg	8.0	8.2	8.2	7.7
Feed efficiency, kg/kg	0.194	0.196	0.182	0.202
Hot carcass wt., kg	234	243	240	247
Dressing, %	53.2	53.7	53.2	54.3
Ribeye area, cm ²	55.9	60.2	58.1	62.0
Fat thickness, mm	7.0	7.1	5.3	4.7

Key Words: Body Composition, Citrus Pulp, Pectin

1335 Ensiling apple pomace to extend its storage life for feeding beef cattle. S. M. Landblom*, J. J. Kinsman, K. A. Johnson, R. L. Kincaid, and J. D. Cronrath, *Washington State University, Pullman.*

To determine the feeding value of apple pomace silage (APS) for growing beef cattle, apple pomace was obtained from a commercial plant and ensiled with 5% alfalfa hay and 7.5% rolled barley (wet basis). A 3 × 3 Latin square design and 24 heifers were used in a feeding trial using the APS. The three diets consisted of (DM basis) a control diet (C, 59.5% ground bluegrass hay, 17% alfalfa hay, and 22% rolled barley), a low APS diet (LAPS, APS at 43.4% of the diet DM), and a high APS diet (HAPS, APS at 89% of the diet DM). A urea-based supplement was fed to insure all diets were isonitrogenous and all mineral requirements were met. There were 2 replicates per treatment and 4 heifers per pen. Diets were fed for 21 d after which heifers were weighed and diets switched. Feed intake was measured daily and heifers were fed for ad libitum consumption. There was no difference in pH, volatile fatty acid concentrations or ADIN over the ensiling process. Chemical composition of the apple pomace was 22.2% DM, 8.3% crude protein, 51.2% NDF, 39.9% ADF, 4.5% ash. Chemical composition of the APS was 21.8% DM, 12% crude protein, 57% NDF, 43% ADF, 5.2% ash, .9% ADIN and .54% soluble-N. Heifer ADG was unaffected by dietary treatment, but heifers fed the HAPS diet tended to have lower ($P = .21$) daily gains (C, .91; LAPS; .84, HAPS; .76 kg/d). Heifers fed the C diet tended ($P = .12$) to eat less than those fed the other diets (C, 6.4 : LAPS, 6.8; HAPS, 6.6 kg/d). Feed efficiencies tended to be the lowest ($P = .16$) for the C diet than the LAPS and HAPS diets (C, 7.8; LAPS, 8.3; HAPS 10.3 ± .91 kg feed/kg gain). Apple pomace can be effectively ensiled and stored for prolonged feeding and can provide an acceptable alternative to hay in growing animal diets.

Key Words: Cattle, By-products, Apple Pomace

1336 Sites of digestion and bacterial protein synthesis in Holstein cows fed a fresh-winter oats based diet and supplemented with concentrates containing different levels of either sunflower or feather meal. S. E. Lavandera*¹, F. J. Santini², S. C. Garcia³, and D. H. Rearte², ¹ *XI Curso de Posgrado en Produccion Animal, Balcarce*, ² *Unidad Integrada Balcarce (INTA - Fac. Cs. Agrs.) (Argentina)*, ³ *Actual adress: Massey University, (New Zealand)*.

Four Holstein cows (478 ± 30 kg) fitted with ruminal, duodenal and ileal cannulas were utilized in a 4 × 4 Latin Square design to investigate the effects of source sunflower meal or feather meal (SM or FM) and amount of CP in the total diet (14% or 18%) on sites of digestion of nutrients and bacterial protein synthesis (BPS). Three times a day, cows were individually fed ad libitum a diet of fresh winter oats (CP = 13.7%, IVOMD = 79.1%), and supplemented with pelleted concentrate at a rate of 1.2% of the BW. Concentrates contained ground corn, wheat bran and two levels of SM or FM for Low (L) and High (H) of CP. Orthogonal comparisons were made to test source (SM vs. FM) and level (L of H) vs. CP, and interaction (source × level). OM intake (kg OM/d) (avg: 12.2, SEM = .26) was not altered ($P > .14$) by source or amount of CP. Total tract and ruminal digestibilities (%) of OM (avg: 72 and 29), was not altered ($P > .10$) by source or amount of CP. Ruminal NDF digestibility was similar among treatments (avg: 40) ($P > .15$), although total tract NDF digestibility was higher ($P < .01$) for H than for L CP diet. (avg: 56 and 46). Duodenal flows (g/d) of total N (TN) and nonammonia N (NAN) were not different among treatments (avg: 367 and 363). Duodenal flow (g/d) of bacterial N (BN) tended ($P = .08$) to be higher for SM (avg: 174) than for FM (avg: 125). Efficiency of BPS (g BN/kg OM apparently or truly digested in rumen) was similar ($P > .30$) among treatments (avg: 65 and 44). Duodenal flow (g/d) of nonammoniacal nonbacterial N (NANBN) was higher ($P = .004$) for FM (avg: 252) than for SM (avg: 175). Feeding SM to cows tended to increase bacterial protein synthesis compared to FM fed cows; and feeding FM increased NANBN compared to SM, but duodenal flows of TN and NAN were not altered by source or amount of CP.

Key Words: Fresh Forage, Protein Supplementation, Digestion

1337 Comparison of whole cottonseed and an extruded sunflower product for early lactation dairy cows. G.D. Marx, *University of Minnesota, Northwest Experiment Station, Crookston.*

Twenty early lactation primiparous and multiparous Holstein cows were fed a high energy, protein and fiber product from two sources over 12 wk preceded by a 2 wk standardizing period. Fuzzy whole cottonseeds (WCS) were fed to one group and an extruded product consisting primarily of whole sunflower seeds (ESS) was fed to a second group at 10% of the ration dry matter. The balance of the ration consisted of alfalfa haylage, corn silage, high-moisture corn, soybean meal, vitamins and minerals fed as a TMR that met NRC requirements for high producing cows. General linear models of SAS were utilized to determine statistical significance of the data. Daily production of milk, fat and protein for cows fed WCS were 30.45, 1.20 and 0.92 kg and cows fed ESS were 31.09, 1.22 and 0.95 kg. Milk production and milk composition did not differ ($P > 0.05$) between groups. Daily feed intakes did not differ between treatments and were 21.45 and 21.49 kg DM for the WCS and ESS fed cows. Average numerical body condition scores were similar for both the WCS and ESS groups with scores of 3.23 and 3.28. Identical BW daily gains of 0.25 kg resulted for both groups during the experimental period. The SCC of milk with the WCS treatment was slightly higher than the ESS treatment group. Reproduction data was limited but indicated no differences in number of services and subsequent conception between treatments. No unusual health conditions or nutritional disorders occurred with any of the cows. Results of this feeding trial indicate that extruded whole sunflower seeds and fuzzy whole cottonseeds were equally acceptable as a high-nutrient supplement in early lactation dairy cow rations.

Key Words: Early Lactation—Dairy, Feed Supplements—Dairy

1338 Effect of substitution of chickpeas by sorghum grain on total tract digestion characteristics in sheep fed finishing diets. J. F. Obregón*¹ and R. Barajas¹, *EMVZ/Universidad Autonoma de Sinaloa. Culiacan, Sinaloa (Mexico).*

To determine the effect of substituting of chickpeas by sorghum grain on total tract digestion characteristics in sheep fed finishing diets, were used four St. Croix lambs (17.13 Kg of BW) in a 4 × 4 latin square design experiment. The diets in that consisting the treatments were: 1) Control, a 12:88 roughage:concentrate diet with 15% CP and 3.5 Mcal DE/Kg, containing 64% (DM) of ground sorghum grain (GSG); 2) Diet as control but substituting 10% of GSG with ground chickpeas (CHP); 3) Diet with 20% of CHP and 44% of GSG; and 4) Diet with 30% of CHP and 34% of GSG. The substitution up to 20% of CHP by GSG had not effect ($P > .10$) on DM, OM and N total tract digestion. The 30% CHP level in the diet, increased ($P < .05$) total tract digestion of DM (81.5 vs 84.7%), OM (83.8 vs 86.3%), and N (71.9 vs 78.9%). The 30% CHP treatment increased ($P < .05$) the DE content of the diet (3.51 vs 3.66 Mcal/Kg). The calculated OM digestibility of CHP was 88.3%, N digestibility of CHP was 97% and DE for sheep was estimated in 4.31 Mcal/Kg.

It is concluded that chickpeas is can substitute partially the grain in finishing diets for sheep and that its nutritional value is higher than sorghum grain.

Key Words: Chickpeas, Digestion, Sheep

1339 **Supplementation of low quality forage diets of dairy cows with nitrogen molasses blocks in Central Tanzania.** J. C. Plaizier¹, R. N. Nkya*², M. S. Shem², B. W. McBride¹, and N. A. Urio², ¹University of Guelph, Guelph, Ontario, Canada, ²Sokoine University, Morogoro, Tanzania.

The effects of supplementation with nitrogen molasses mineral blocks (NMMB) and molasses urea mix (MUM) during the dry season on the production of dairy cows were studied on the experimental farm of Sokoine University. All cows received a tropical grass hay *ad libitum* and 6 kg/d of maize bran. NMMB consisted of molasses (30%), urea (10%), limestone (5%), salt (2.5%), bone meal (2.5%), maize bran (36%). Cement (14%) was added as a binder. A maximum of 2 kg/d of NMMB was provided. NMMB supplementation increased milk production from 6.7 L/d to 11.2 L/d ($P < 0.001$), increased dry matter intake from 10.0 kg/d to 11.9 kg/d ($P < 0.01$), but did not significantly affect milk composition, intake of hay, and live weight changes. MUM consisted of molasses (83%), urea (3%), and water (14%). MUM was mixed with the grass hay and fed at a level of 2 L/d. Supplementation with MUM increased daily milk yield from 6.7 L/d to 8.8 L/d, but did not significantly affect the other measured production parameters. Increases in milk yield due to NMMB and MUM are mainly explained by increased intakes of energy and nitrogen. Calculated on a cost recovery basis, supplementation with NMMB and MUM are cost effective if milk yields are increased by at least 0.7 L/d. Hence, if these supplements can be provided on a cost recovery basis, then feeding these supplements to lactating dairy cows in the Morogoro region during the dry season can be recommended.

Key Words: Urea, Molasses, Tanzania

1340 **Effect of the substitution of soyhulls for barley grain in diets for fattening lambs.** C. A. Rodriguez, P. Garcia, G. G. Mateos*, and C. de Blas, *Universidad Politecnica de Madrid, Spain.*

Partial replacement of rapidly degradable starch concentrates by highly digestible low lignified sources of fiber, as soyhulls, in diets for intensively reared ruminants may reduce ruminal acidosis and be an economic alternative in commercial feeds. A trial was conducted to study the use of soyhulls in concentrated diets for feedlot lambs. Four experimental diets were made by substituting (w/w) 5, 10 or 15% of soyhulls for barley grain in a pelleted commercial diet. The basal diet was constituted by barley grain (63%), fullfat soybeans (1.5%), soybean meal (19%), wheat bran (11.3%), lard (1.5%) and a premix (3.7%). Three hundred and twenty male and female Entrefino lambs weighing as average 12.0 ± 0.5 kg, were allotted to the four treatments so that average initial weight in each treatment were homogeneous. Lambs were weaned at 44 d and given *ad libitum* access to diets and wheat straw during a 41 d feeding trial. Animals were housed in pens of ten (eight replicates per treatment). Initial weight of lambs was used as a linear covariate in the model. Type of diet did not affect any of the traits studied when dietary level of inclusion of soyhulls was below 10%. However, substitution of 15% soyhulls for barley grain impaired weight gain in the earlier fattening period (0–28 d) with respect to the average of the other three diets (204 vs 238 g/day, $P = .002$) and feed conversion rate throughout all the experiment (3.50 vs 2.98 g feed/g weight gain, $P < .001$). An interaction was found between type of diet and fattening period, so that performance of the diet containing 15% of soyhulls was relatively better in the finishing (28–41 d) than in the growing (0–28 d) period. Wheat straw intake was not affected by treatment. Sex did not affect any of the traits studied. It is concluded that soyhulls can be used successfully as a substitute of barley grain at levels of up to 10% without any impairment on lamb performance.

Key Words: Soyhulls, Fattening Lambs, Feeding Trial

1341 **Effect of maturity at harvest on efficiency of utilisation of whole-crop wheat for milk production.** J. D. Sutton*, R. H. Phipps, and D. J. Humphries, *CEDAR, Department of Agriculture, The University of Reading, Reading, UK.*

Whole-crop wheat (WCW) offers an alternative forage to grass or maize silage but its nutritional value varies with stage of maturity at harvest. To quantify the effects of maturity in terms of the efficiency of WCW utilisation for milk production, winter wheat was harvested at 29% (Low) and 48% (Medium) dry matter (DM) and ensiled without additives, 48% DM and treated with a non-cellulolytic enzyme (Medium/E), and at 60% DM (High) and preserved with 40 kg urea/t DM. The forages were fed *ad libitum* in a 2:1 DM ratio with grass silage and were supplemented with 8.6 kg concentrate DM/d in a 4 × 4 Latin square experiment with 4 multiparous cows in early to mid lactation. Total collections of faeces and urine were made for 6 d in the fifth week of each period; methane and metabolisable energy (ME) were estimated. There were no significant differences between Medium and Medium/E ($P > 0.10$) and results for Medium/E will not be reported. With increasing maturity, the WCW contained (g/kg DM) 517, 474, 423 neutral detergent fibre (NDF); 26, 199, 319 starch; and 115, 95, 197 crude protein (CP) respectively. Intake of DM (20.8, 20.7, 21.7 kg/d, $P > 0.10$) and milk yield (31.5, 33.2, 31.0 kg/d, $P > 0.10$) were unaffected by maturity. Digestibility (%) was reduced on Medium for DM (68.0, 65.7, 67.6, $P < 0.05$), NDF (56.8, 51.6, 59.7, $P < 0.05$) and total N (68.7, 63.6, 67.3, $P < 0.01$) and on High for starch (96.4, 96.6, 92.6, $P < 0.01$). Energy digestibility was reduced on Medium and High (68.8, 66.2, 67.1, $P < 0.05$). Application of these results to a feeding trial conducted simultaneously with the same diets suggested that Milk energy/ME was reduced on High (0.425, 0.425, 0.411). Losses of N in urine (240, 199, 295 g/d, $P < 0.001$) and feces (183, 203, 234 g/d, $P < 0.05$) were increased on High due to the urea treatment. In practice the reduced digestibility of Medium compared with Low may be outweighed by higher yields/hectare whilst N pollution and reduced starch digestion are problems with High.

Key Words: Whole-crop Wheat, Digestibility, Lactation

1342 **Effect of the substitution of navy beans (*Phaseolus vulgaris*) by sorghum grain on total tract digestibility in sheep fed finishing diets.** M. Valdez*¹ and R. Barajas¹, *EMVZ/Universidad Autonoma de Sinaloa, (Mexico).*

Four St. Croix lambs (21.5 Kg of BW) were used in a latin square design experiment, to determine the effect of the substitution of navy beans by sorghum grain on total tract digestibility in sheep fed finishing diets. The treatments were: 1) Basal diet with 16% CP and 3.46 Mcal DE/Kg (20% alfalfa hay - 80% concentrate), containing 56% of ground sorghum grain; treatments 2, 3, and 4 consisted in a substitution of 10, 20, and 30% respectively of the sorghum grain using cooked navy beans as substitute. The DM and OM intake were not affected ($P > .10$) across the different treatments. The CP intake was increased ($P < .01$) for each increment of navy beans level in the diet (140, 149, 160 and 171 g of CP/day, respectively). The total tract apparent digestibility of DM and OM of the experiment were 80.17 and 81.89%, and they were not affected ($P > .10$) by treatments, the mean DE of diets was 3.46 Mcal/Kg and was not affected ($P > .10$) by navy beans level in the diet. The 30% of navy beans level increased ($P < .05$) in 6% the digestibility of CP of the diet with respect to basal diet (73.38 vs 78.84), there were not differences ($P > .10$) between the other three treatments. The true digestibility CP navy beans was calculated in 90% using as reference value a 77% of digestibility for CP of sorghum grain.

It is concluded that it is possible use navy beans for substitute sorghum grain in sheep diets without reduction in energetic value of the diet, and with the benefit of a high level of CP with better digestibility.

Key Words: Navy Beans, Digestibility, Sheep

1343 The effects of wet brewers grain on the net portal fluxes of ammonia, urea and amino acids in dairy cows. A. M. van Vuuren¹, A. Klop¹, G. A. L. Meijer¹, H. de Visser¹, and E. de Koning^{2*}, ¹DLO-Institute for Animal Science and Health, Lelystad ²Bonda's Veevoederbureau, Hillegom, The Netherlands.

Farmers obtain higher milk production when feeding wet brewers grain (WBG) than is predicted from feed analyses. It is possible that the absorbable protein (AP) value of WBG is larger than in situ estimates suggest. Therefore, an experiment was done to estimate the effect of WBG on the net flux of nitrogenous components across portal drained viscera (PDV) of dairy cows. Four dairy cows with a rumen cannula and catheters in the portal and hepatic vein and in a mesenteric artery received a TMR containing concentrates and either pre-wilted grass silage or corn silage. The basal diet was fed as such (14.2 kg DM) or supplemented with 4.1 kg DM from WBG or with 4.1 kg DM from a mixture (85:15) of WBG and citruspulp (WBG+). Due to catheter obstructions, blood sampling was incomplete and the effect of citruspulp could not be statistically analyzed. Supplementation with WBG or WBG+ led to a higher energy intake, more milk, and a higher portal blood flow. Supplementation increased net urea uptake and net AA-N release by the PDV. According to the tabulated value, supplementation with WBG should have increased the AP supply by approximately 0.4 kg/d. However, extrapolating the extra net portal AA-N flux to an AA-protein flux indicated an increase in actual AP of 0.7 to 1.2 kg/d. These results suggest that the AP value of WBG is higher than presently assumed.

Parameter	Grass silage			Corn silage			SED
	Contr	WBG	WBG+	Contr	WBG	WBG+	
AP intake, kg/d ^a	1.22	1.60	1.62	1.29	1.63	1.68	-
Urea-N flux, mol/h	-0.10	-0.39	-0.40	-0.20	-0.31	-0.39	0.10
NH ₃ -N flux, mol/h	0.36	0.47	0.46	0.32	0.50	0.43	0.15
AA-N flux, mol/h	0.44	0.80	0.90	0.45	1.11	0.97	0.30
AA-protein flux, kg/d	0.83	1.52	1.70	0.85	2.09	1.79	0.57

^aCalculated as digestible protein in small intestine (DVE)

Key Words: Dairy Cattle, Protein, Portal Flux

1344 Effects of alcohol-fermented feedstuffs on improvement of meat production and quality of Korean cattle. C. G. Yan, J. S. Oh, J. S. Shin, B. W. Kim*, and B. J. Hong, Kangwon National University, Korea.

Generally alcohol has been known to increase the efficiency of diets when it was fed to animals. However no information is presently available about the effect of the feedstuff fermented with yeast on animals. The objective of this study is to investigate the effects of the alcohol-fermented feedstuff (AFF) on growth performance and carcass trait of growing Korean cattle. The diet consisted of 80% corn and 20% oat was added with 50% water, 10% molasses, and 5% yeast and fermented for 4 h at 32°C. Twenty six Korean cattle averaging 230kg were randomly assigned into two dietary treatments (AFF; AFF+ rice straw and Control; non-fermented corn and oat + rice straw). Daily gains during growing, fattening, and finishing periods were 1.24, 0.95, and 1.02kg in AFF and 1.03, 0.81, and 0.86 kg in control, respectively. No difference was observed in back-fat thickness between AFF and control, but rib-eye area of AFF was 86.14cm² compared to 80.50cm² of control. These observations are partially due to differences in the feed intake and energy of two diets.

Key Words: Alcohol-fermented, Korean Cattle, Carcass

1345 Effects of alcohol-fermented feedstuffs on blood metabolites and meat composition of Korean cattle. C. G. Yan, J. S. Oh, J. S. Shin*, B. W. Kim, and B. J. Hong, Kangwon National University, Korea.

The purpose of this research was to examine the effects of alcohol fermented feedstuffs (AFF) on blood metabolites, back loin composition, amino acid and fat acid composition. The AFF consisted of 80% corn and 20% oat was added with 50% water, 10% molasses, and 5% yeast and fermented for 4 h at 32°C. This trial was a completely randomized design using 36 Korean male cattle assigned into two dietary treatments (AFF; AFF+ rice straw and Control; non fermented corn and oat + rice straw). In AFF, the contents of glucose, cholesterol, and triglyceride during each period (growing, fattening, and finishing) were significantly higher, but blood urea nitrogen content was lower. These are resulted from the increased activity of microorganism in the rumen due to alcohol. The saturated fatty acid contents of back loin were lower in AFF, while unsaturated fatty acid contents tended to increase. Oleic acid content was significantly higher in AFF than control; 50.15% and 46.97%, respectively (P<0.05). These results indicate that an alcohol play an role to prevent the diets in the rumen from saturating.

Key Words: Alcohol-fermented, Korean Cattle, Blood

1346 Influence of sodium caseinate abomasal infusion on voluntary feed intake and digestive function in steers fed a forage-based diet. E. G. Alvarez^{1*} and R. A. Zinn^{1,2}, ¹Universidad Autonoma de Baja California, Mexicali (Mexico), ²University of California, El Centro.

Six Holstein steers (405 kg) with cannulas in the rumen and proximal duodenum were used in a replicated 3 × 3 Latin square design experiment to evaluate the effect of abomasal infusion of Sodium Caseinate (0, 150, or 300 g/d) on voluntary feed intake and digestive function. The basal diet contained 9% crude protein and 31% ADF (DM basis). Infusion into the abomasum was accomplished by passing a 4mm i.d tube through the ruminal cannula and into the abomasum via the reticular groove. The experiment included six 9-d periods. On d 4, 5, and 6 of each period the ad-libitum DMI was registered. There were no treatment effects (P > .10) on DMI. Ruminal digestion of OM, ADF and feed N were increased (linear component, P < .10) with level of casein infusion. There were no treatment effects (P > .10) on microbial efficiency. Ruminal N efficiency and post-ruminal N digestion were increased (linear component, P < .01) with level of casein infusion. Casein infusion decreased (linear component, P < .01) total tract digestion of OM and increased (linear component, P < .01) total tract digestion of N.

Key Words: Casein, Abomasal Infusion, Cattle

1347 Intestinal disappearance of rumen-protected methionine (Mepron[®] M85) determined in situ versus in vivo. R. Berthiaume^{*1}, H. Lapierre², R. Burzins³, N. Cote¹, and B. W. McBride¹, ¹University of Guelph, On Canada, ²Dairy and Swine R&D Centre, Lennoxville Quebec, Canada, and ³University of Alberta, Edmonton, Ab Canada..

Intestinal disappearance of rumen-protected methionine (RPM) is usually determined in situ with the mobile nylon bag technique. We hypothesized that this method could underestimate intestinal disappearance of Mepron[®] M85 (Degussa, Richfield Park NJ) since it is coated with a cellulose matrix which is not completely destroyed in the abomasum. In such cases, the nylon bag could act as a physical barrier between RPM particles and digestive enzymes. A switchback experiment was designed to compare the disappearance of RPM determined in situ or in vivo over 3 consecutive periods. Four non-lactating Holstein heifers (477 ± 36 kg) with cannulae in the rumen, duodenum and ileum were fed a diet based on timothy silage to meet requirements for maintenance (DMI = 8.72 ± 0.15 kg). A total of 16 bags were incubated in the rumen (4.5h) of each cow and transferred to an acid pepsin solution to simulate the abomasum (2.5h). Following each incubation bags were recovered and 3 bags were dried at 55 ° C and analyzed for methionine (MET). Remaining bags (in situ) or their content that had been transferred into gelatin capsules (in vivo) were introduced in the duodenal cannula. Spot samples of digesta were collected during a 96-h period, with Co-EDTA and Cr mordanted fiber used as indigestible markers to estimate in vivo digestibility. MET content of RPM and residues remaining in bags after ruminal and abomasal fermentation and after collection from the feces were used to calculate ruminal, abomasal and intestinal disappearance of MET, respectively. Disappearance of MET in the rumen and abomasum averaged respectively 16.5 ± 1.0 and 5.2 ± 1.1 %. Intestinal disappearance of MET determined in vivo was significantly ($P \leq 0.005$) higher than in situ (76.5 vs 39.0 ± 2.7 %). Our results indicate that when used to assess intestinal availability of RPM, the mobile nylon bag technique can underestimate the true bioavailability of MET.

Key Words: Methionine, Ruminally Protected Amino Acids, Dairy Cows

1348 Plasma amino acid and ruminal responses to supplemental DL-methionine in feed or drinking water by adults Angora goats. H. Carneiro^{*1}, T. Sahlu², and F. N. Owens³, ¹Embrapa, Gado de Leite and CNPq, ²E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, and ³Oklahoma State University, Stillwater, OK .

Ruminal and plasma amino acid and responses to providing supplemental DL-methionine (met) in either drinking water or feed was studied in three adult fistulated (45kg) wethers. These goats received either 1) the basal diet containing 0.15% of S, 2) the basal diet plus 2.5 g of DL-met daily in their drinking water for a S intake equivalent to 0.18% dietary S, or 3) the basal diet plus 2.5 g of DL-met daily top-dressed on the feed daily (0.18% dietary S). They had ad libitum access to 40% roughage diet (13.8% CP). Methionine supplemented in water or feed increased plasma concentrations of glu, arg, met, and of met as a percentage of EAA or of total amino acids. Plasma met concentrations were highest when met was added in the top of the feed; val, met, and met as a percentage of EAA or total AA were increased by met supplementation. Phe was higher when met was placed in drinking water. Plasma concentrations of ser, thr, ala, tyr, val, leu, total, EAA and NEAA exhibited quadratic responses over time post-feeding peaking 1 hr post-feeding. Only met as a percentage of total AA was increased linearly by met supplementation. Ruminal ammonia decreased when DL-met was added to the diet. VFA ratios, protozoal numbers, and pH were not altered by added met. In summary, met supplement in water or feed increased plasma met. Responses to met in water need to be tested with goats fed a higher dietary S level to determine if equal responses can be attributed to organic and inorganic dietary S.

Key Words: Goats, Sulfur, Amino Acids

1349 The influence of adding methionine to the drinking water or to feed on the growth rate of mohair by Angora kids goats. H. Carneiro¹, T. Sahlu^{*2}, and F. N. Owens³, ¹Embrapa, Gado de Leite and CNPq, ²E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, and ³OSU, Stillwater, OK.

Effects of supplementing sulfur either in the drinking water as DL-methionine or as top-dressed on feed as sodium sulfate on feed on mohair production were examined in two experiments with Angora kids. In the first trial, no added sulfur was compared with supplements of 2.5g DL-methionine in the drinking water or an equivalent amount of sulfur from sodium sulfate (2.4g) top-dressed on feed. Each treatment was provided to four 12-month old wether goats (37kg) for 60 days. The basal diet, containing 40% roughage, 13.8% protein and .26% sulfur, was available free choice. In the second trial, the same 12 animals were used in a crossover design (30d/periods) to compare supplemental methionine in water with sodium sulfate added to the feed. Rates and efficiencies of gain and mohair production were not altered either by sulfur supplementation or by sulfur source. However, plasma met concentrations were increased ($P < .02$) by met in the water indicating that methionine in drinking water increased post-ruminal methionine supply. However, failure of supplemental DL-methionine to increase mohair production suggests that the post-ruminal methionine supply already was adequate for maximum growth (25g/d) of mohair.

Key Words: Methionine, Goats, Sulfur

1350 Effects of supplemental sulfur on amino acid composition of ruminal bacteria isolated from goats. H. Carneiro¹, F. N. Owens², R. Puchala³, T. Sahlu³, and K. Qi^{*3}, ¹Embrapa, Gado de Leite/CNPq scholarship ²OSU, Stillwater, OK ³E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.

To determine whether a dietary deficiency of sulfur (S) will alter the amino acid (AA) composition of protein of isolated ruminal bacteria, 12 Angora (18kg) and 20 Alpine (24kg) castrated male goats kids were individually fed isonitrogenous and isocaloric diets containing 2.28% N and either .11 (basal), .20, .28 or .38% of S for 10 weeks. Added S came from supplemental CaSO₄. Non-attached ruminal bacteria were isolated by differential centrifugation and analyzed for AA composition. Differences between the two breeds were detected in AA composition of ruminal bacteria (mg/g DM) for lys ($P < .07$) and the phenolic AA ($P < .03$). Among the nonessential AA (NEAA), differences were noted for asp ($P < .15$), pro ($P < .01$) and tyr ($P < .02$). Breed and total AA concentration generally were higher for bacteria from Angora than Alpine goats. As a percentage of EAA, differences were small but values remained greater for lys ($P < .02$) and his ($P < .08$) for Angora and higher proportion of met ($P < .16$), and phe ($P < .11$) for Alpine. Many of the Alpine goats were defaunated. Perhaps this is responsible for the breed differences detected. Sulfur supplementation of the diet produced a quadratic increase in cys concentration when expressed as mg/g bacterial DM ($P < .08$), and a linear increase ($P < .05$) when expressed as g/100g of total AA of bacteria. Sulfur supplementation also linearly increased ser expressed either as mg/g bacterial DM ($P < .07$) or as g/100g of total AA ($P < .10$). Added sulfur tended to linearly decrease concentrations of phe, thr and ala ($P < .11$; $P < .16$; and $P < .07$) when expressed per 100 g of AA. Added S linearly decreased ($P < .07$) total EAA and but increased ($P < .15$) total NEAA. Adding CaSO₄ in the diet of growing kids altered AA composition of protein of isolated ruminal bacteria, increasing the proportional concentrations of cys and ser but not of met.

Key Words: Amino Acid Composition, Ruminal Bacteria, Goats

1351 Growing Angora goat responses to dietary sulfur and DL-methionine in drinking water. H. Carneiro¹, T. Sahlü², and F. N. Owens^{3*}, ¹Embrapa, Gado de Leite and CNPq ²E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK ³OSU, Stillwater, OK.

To examine production and metabolic responses to supplemental DL-methionine (met) provided in the drinking water or feed, 14 one year old young Angora goats (29kg) were given ad libitum access to a 40% roughage diet (13.8% CP; .15% of S) for 60 days in a completely randomized design. Three or four kids in individual pens received either 1) the basal diet 2) the basal diet plus 2.5g/d of DL-met in drinking water, 3) the basal diet supplemented with NaSO₄ to equal 0.20% S, or 4) treatment 3 plus 2.5 g of met daily in the feed. S intakes provided the dietary equivalents of .15, .18, .20, and .23% S. Feed intake tended to increase (P<.15) when met was provided either in drinking water (1077 vs 1020) or in the feed (1066 vs 1012). Top-dressing the 0.20% S diet with DL-met increased (P<.11) clean mohair production by 35% (.74, .76, .87, and 1.00 kg/animal/treatment). Plasma concentrations of met, thr, ala, arg, tyr, cys, ile, leu, lys were increased by higher S levels. Glu, gly, thr, val, ile and lys reached peak plasma concentrations with .20% S. For these young weathers, mohair production (g/d) was greatest (17 g/d) at .23% dietary S (from sulfate plus methionine) at a N:S ratio of 9.6.

Key Words: Young Goats , Amino Acid

1352 Duodenal amino acid profile requirements of South African Mutton Merino lambs. A. V. Ferreira^{*1}, H. J. Van der Merwe², A. B. Mallo², and M. D. Fair², ¹University of Stellenbosch, Matieland, South Africa, ²University of the Orange Free State, Bloemfontein, South Africa.

The nitrogen utilization of South African Mutton Merino ram lambs fed a standard finishing diet supplemented with essential amino acids (EAA's) to eliminate imbalances in the duodenum was investigated. Twenty-eight lambs (138 kg) fitted with abomasal cannulas were randomly allocated to four groups of seven each. The diet consisted (g/kg air dry weight) of 300 alfalfa, 80 wheat straw, 562.5 com, 35 molasses meal, 10 urea, 5 salt, 7.5 ammonium chloride and 0.29 taurotec. An EAA mixture was calculated in a previous study to simulate the EAA composition of the whole empty body in the duodenum. The mixture consisted of (g/kg): 119.7 arginine, 154.9 histidine, 22.1 isoleucine, 106.5 leucine, 91.5 lysine, 146.9 methionine, 105.6 phenylalanine, 133.8 threonine and 118.7 valine. The EAA mixture was infused at the following levels (g/lamb/day): 0.00, 38.27, 51.02 and 63.78, with adaptation and collection periods of 2 and 4 days each. Glisine was used to bring the various mixtures to a nitrogen equivalent basis. Omission of the first (histidine), second (methionine) or third (threonine) limiting EAA from the mixture on nitrogen utilization was also investigated using the same lambs. Infusion of 51.02 g/lamb/day of the EAA mixture resulted in a significantly (P<0.07) increase in nitrogen retention expressed as a percentage of nitrogen intake. On the other hand the omission of a single limiting amino acid from the mixture (51.02 g/lamb/day), non-significantly (P>0.05) reduced nitrogen retention.

Key Words: Essential Amino Acids, Nitrogen Metabolism, Lambs

1353 Variation in amino acid composition of intensively sampled dairy feed ingredients. C. R. Llamas*, R. A. Patton, and C. J. Peel, *Degussa Corporation.*

Feed samples were collected at two week intervals from 8 farm trials where bypass methionine was fed (Mepron[®] M85) for the first 160 days of lactation to measure the variability in CP, NDF, methionine, lysine, leucine, isoleucine, valine and threonine. Analyses were performed in the Degussa Laboratory (Allendale, NJ) using accepted laboratory methods. Crude protein and NDF varied greatly among forages and by-product feeds. Amino acid compositions were stable for most grain products and alfalfa hay. Amino acids were variable for silages and by-products even when crude protein contents were equal. Among amino acids, lysine showed the greatest coefficient of variation. The means and coefficients of variation of the analyses are presented below as per cent of dry matter.

Ingredient	n	CP		NDF		Methionine		Lysine		Leucine	
		Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Alfa haylage	91	22.1	16.1	48.1	11.4	0.29	29.5	0.79	29.1	1.36	28.2
Corn silage	114	9.6	39.2	46.6	12.3	0.16	47.0	0.26	64.5	0.76	43.6
Alfa hay	35	21.1	12.3	46.6	15.6	0.30	14.0	0.95	16.8	1.38	14.5
HM shell corn	20	9.4	13.0	16.2	19.9	0.20	16.2	0.26	12.2	1.09	13.3
Dry shell corn	87	9.7	13.4	14.9	15.3	0.21	11.9	0.28	20.8	1.09	13.9
HM ear corn	14	8.6	15.2	32.4	27.5	0.19	25.2	0.19	60.7	0.94	18.8
Soymeal 48	73	54.2	3.5	11.0	18.2	0.77	6.0	3.19	4.9	3.98	3.5
Corn gluten fd	17	22.4	7.6	40.4	10.1	0.39	14.4	0.68	17.8	1.83	10.6
Rst soybeans	15	42.9	7.1	25.2	16.2	0.63	3.9	2.56	11.9	3.17	4.6
Cottonseed	81	24.5	11.1	51.6	13.0	0.40	13.6	1.01	11.3	1.36	15.5
Dist grains	40	30.2	10.3	50.5	20.0	0.56	13.6	0.73	22.5	3.17	19.6

For precision protein feeding of dairy cattle, the amino acid composition of feed ingredients will need to be considered.

Key Words: Feed Analyses, Amino Acids

1354 Effects of protected methionine (Mepron[®] M85) on milk yield and composition on commercial dairy farms. R. A. Patton, C. J. Peel, and W. Heimbeck*, *Degussa Corporation, Ridgefield Park, NJ.*

This study was conducted on commercial dairy farms throughout the US to evaluate the effects of rumen by-pass methionine (Mepron[®] M85) on milk production and milk composition in the first half of lactation. Mepron was added as a supplement (20g/cow/day) from day 0 to 160 of lactation. No changes were made to diets except for Mepron addition. Factors evaluated were herd, parity (primiparous versus multiparous) and Mepron addition.

Farm	Parity	n	Control			Mepron Difference			Linear Contrast*		
			Milk	Fat%	Pro%	Milk	Fat%	Pro%	Milk	Fat%	Pro%
WI-1	Primi	17	35.1	3.86	3.30	0.5	0.09	-0.12	b	a	a
	Multi	24	47.5	3.73	3.39	4.4	0.20	-0.20			
WI-2	Primi	36	30.0	3.58	3.24	3.3	-0.29	-0.19	b	a	a
	Multi	19	40.8	3.68	3.14	1.2	-0.25	-0.23			
MN	Primi	39	37.5	3.30	2.88	-0.2	0.17	0.13	b	a	
	Multi	37	46.3	3.29	2.88	2.7	0.23	0.01			
PA	Primi	10	27.0	3.82	3.18	5.0	-0.36	-0.07	b	a	
	Multi	28	38.5	3.64	3.09	-1.3	-0.18	-0.02			
MD	Primi	49	41.7	3.79	3.00	0.1	0.27	0.10	a	a	
	Multi	21	46.1	3.96	3.02	1.2	0.07	0.04			
MI	Primi	29	38.8	3.59	2.91	0.7	-0.19	0.01	b	a	a
	Multi	69	48.5	3.49	2.97	-0.9	0.07	0.11			
KA	Primi	11	34.5	3.69	3.01	-1.8	0.05	0.09	b	b	
	Multi	21	46.1	3.96	3.02	1.2	0.07	0.04			
NY	Primi	22	34.1	3.90	2.84	-2.0	0.11	0.15	a	a	
	Multi	18	41.5	3.65	2.95	-2.5	0.18	0.14			

*Linear contrast of milk (kg/cow/day), fat% and protein%.
 a = significant effect of treatment (P<.05).
 b = significant treatment*parity interaction (P<.05).
 Responses of milk (kg/cow/day) and milk components to Mepron were variable. Significant parity*treatment interactions for milk production occurred in 6 of 8 herds. Rumen by-pass methionine can significantly increase milk and milk components.

Key Words: Amino Acids, Protein

1355 Dietary factors associated with production responses to a rumen protected methionine (Mepron® M85) on commercial dairy farms. C. J. Peel* and R. A. Patton, *De-gussa Corporation, Ridgefield Park, NJ.*

Milk yield and milk composition responses to the supplementation of Mepron® M85, a rumen protected methionine (presented in a companion abstract) were variable. Correlation and regression techniques were utilized to determine if specific dietary factors could account for between farm variation, and to gain insights into the parity*methionine interactions which were often observed. The correlation of some key dietary factors to milk yield response are presented.

Dietary Factor	Correlation	Significance
NEL, Mcal/kg	0.22	
Crude Protein, %	0.33	
NDF, %	0.20	
NFC, %	0.06	
Fat, %	-0.67	P<0.05
Methionine, grams	0.86	P<0.01
Lysine, grams	0.90	P<0.01

*Represents total metabolizable methionine and lysine with contributions from microbial and feed undegraded protein as predicted by the Mepron Evaluator.

The best overall regression model for milk production response to protected methionine included terms for the dietary factors metabolizable lysine, fat percent in diet, and NFC percent ($R^2H = .91, P<0.01$). However, metabolizable lysine accounted for the majority of the variation ($R^2H = .81, P<.01$). Equations for milk yield response by primiparous cows were affected to a greater degree by the percentage of dietary fat in the diet, with higher fat intake having a negative effect on the milk yield response.

We conclude that milk yield responses to Mepron® M85 may be potentiated by high levels of metabolizable lysine and interact with energy sources in the diet.

Key Words: Amino Acids, Protected Methionine

1356 Effect of coating on nitrogen rumen degradation of rumen-protected lysine and methionine. F. Rossi, M. Moschini, F. Masoero, and G. Piva*, *UCSC ISAN, Piacenza, Italy.*

Feeding rumen-protected amino acids to lactating dairy cows to enhance milk yield does not always yield the expected results, probably because the protective layer is differently degraded by the rumen microbes. Four rumen-protected lysine (Lys-A: long chain fatty acids triglycerides and calcium soap fatty acids coated; Lys-B: long chain fatty acids triglycerides; Lys-C and Lys-D: lipid coated) and four rumen-protected methionine (Met-A: ethylcellulose; Met-B: pH sensible polymer; Met-C and Met-D fat coated methionine) were incubated with the nylon bags technique (4 g of sample in each 12 x 8 cm nylon bags, 46 5m pore size) 8 and 24 hours (duplicate for each incubation time for two kinetics) in two fistulated animals. Animals were feeding on 8kg of grass hay, 5kg corn silage and 2kg of concentrate (DMI 10kg, CP: 11% on DM basis). Bags were introduced in the rumen before the morning meal. Recovered bags were washed in tap water and dried in ventilated oven (400°C) until constant weight. Residues were analyzed for the nitrogen content. The lysine rumen degradation was reduced in the Lys-B product, no differences were observed when using calcium soap fatty acids within the protective layer. The implement of a pH-sensible protection (Met-B) had the best result in reducing the N-methionine degradation, either at 8 and 24 hours of incubation.

Incubation time, hours	% of nitrogen rumen degradation				SE
	Lys-A	Lys-B	Lys-C	Lys-D	
8	93.76 ^B	43.14 ^A	97.76 ^B	98.36 ^B	1.818
24	96.26 ^B	69.54 ^A	97.82 ^B	98.96 ^B	1.048
	Met-A	Met-B	Met-C	Met-D	
8	19.40 ^B	1.98 ^A	97.11 ^D	58.07 ^C	.879
24	39.75 ^B	2.08 ^A	97.95 ^D	76.54 ^C	1.05

A, B, C, D P<.01

Key Words: Amino Acids, Cows, Rumen

1357 Essential amino acid composition of the whole body of South African Mutton Merino lambs. H. J. Van der Merwe*¹, A. V. Ferreira², C. A. Loëst¹, and M. D. Fair¹, ¹University of the Orange Free State, Bloemfontein, South Africa, ² University of Stellenbosch, Matieland, South Africa.

The essential amino acid composition of the whole empty body of South African Mutton Merino ram lambs fed a standard diet was investigated. Twenty lambs were randomly allocated to four pre-assigned average slaughter weights (30, 35, 40 and 45 kg live weight). The standard diet consisted (g/kg air dry weight) of 300 alfalfa, 80 wheat straw, 562.5 corn, 35 molasses meal, 10 urea, 5 salt, 7.5 ammonium chloride and 0.29 taurotec. The essential amino acid composition of the carcass, blood, head & feet, skin & wool, liver, lungs, kidneys, heart, spleen, testis, digesta-free gastrointestinal tract (GIT) and whole body were determined. Whole body essential amino acid composition remained similar (P>0.05) regardless of slaughter weight. The concentration of the following essential amino acids increased significantly (P<0.05) with increasing live weight (30, 35, 40 and 45 kg): head & feet valine (3.87^a, 5.56^{ab}, 5.68^{ab}, 6.70^b), spleen phenylalanine (4.96^a, 5.00^a, 5.07^{ab}, 5.56^b) and valine (5.31^a, 5.50^{ab}, 5.69^{ab}, 6.03^b) as well as GIT phenylalanine (5.00^a, 6.50^a, 11.10^a, 18.78^b). Whole empty body essential amino acid composition (g AA/100 g protein) was as follows: 7.72 arginine, 4.54 histidine; 3.06 isoleucine; 8.53 leucine; 6.46 lysine; 3.56 methionine; 5.22 phenylalanine; 4.65 threonine and 5.18 valine. In comparison with the whole cattle or pig empty bodies in the literature, histidine and methionine concentrations were higher probably due to the significantly higher (P<0.05) concentrations in the head & feet, and skin & wool, when compared to the carcass. The average essential amino acid composition of the whole empty body determined in the present study could serve as an ideal example of the essential amino acid requirements of South African Mutton Merino lambs needed for whole empty body growth at tissue level.

Key Words: Essential Amino Acids, Whole Body, Lambs

1358 Effect of tannins on *in vitro* ruminal protein and dry matter degradation of Soybean Meal and Ryegrass. S. Gonzalez*, J. Carulla, and M. Pabsn, *Universidad Nacional, Santafi de Bogota, Colombia.*

Protein can be protected from ruminal degradation by adding tannins which form insoluble tannin-protein compounds in the rumen. The efficiency of Quebracho (*Schinopsis balansae*), Acacia (*Acacia spp*) and Chestnut (*Castanea dentata*) tannins to protect protein of Soybean meal and Ryegrass was determined. Each tannin was added to Soybean meal or Ryegrass at levels of 0, 2, 4 and 8% of dry weight and incubated by triplicate in ruminal liquor and McDougall buffer solution for 48 hours (ruminal) or 48 hours plus 24 hours of pepsin digestion (abomasal). Ammonia concentration at 48 h and DM disappearance after incubation with pepsin (P) or without pepsin (WP) was measured. All tannins decreased ammonia concentration in both substrates. Ammonia concentration at 48 hours for Ryegrass did not differ within tannins, while differences (P<0.01) were observed between sources for Soybean meal. At 8% of tannins added, the N-NH₃ concentration was reduced in 63%, 46% and 33% for Chestnut, Acacia and Quebracho; respectively. All tannins sources depressed Soybean meal dry matter degradation after 48 hours of incubation in ruminal fluid. However, this was partially compensated after pepsin addition (Table 1). Chestnut tannins protect more efficiently the Soybean meal protein from ruminal degradation, without negative effect on the digestibility after pepsin addition.

Table 1. *in vitro* dry matter digestibility of Soybean Meal.

TANNINS LEVEL ¹	QUEBRACHO		ACACIA		CHESTNUT	
	2WP	3P	WP	P	WP	P
	Dry matter degradation (%)					
0(control)	75±1 ⁴	88±2	75±1	88±2	75±1	88±2
2	74±1	85±1	73±4	89±3	67±3	86±4
4	74±1	85±0	71±3	86±1	64±2	88±2
8	70±1	78±3	68±3	82±0	52±2	86±1

¹ As % in weight of substrate incubated. ² WP. 48 h incubation with rumen fluid.

³ P. 48 hours incubation in rumen fluid plus incubation with pepsin for 24 h.

⁴ Values are averages ± standard deviation.

Key Words: Polyphenols, Protein Protection, Ammonia Release

1359 Blood processing: Effects on meal degradability and intestinal digestibility. M. de J. Marichal*, M. Carriquiry, R. Pereda, and R. San Martín, *Facultad de Agronomía, Montevideo, Uruguay.*

Crude protein degradability (nylon bag technique) and intestinal digestibility (mobile bag procedure) of steam coagulated blood, dried by two processes: vat (V) (temperature: 100 to 160°C, drying time: 5 to 7 h) or vat modified (VM) (vacuum applied: 0.2 atmosphere, temperature 70°C, drying time: 1–2h) were estimated. Four blood meals samples/process, obtained from industrial plants, averaging 92 and 86 % crude protein on DM for V and VM respectively, were evaluated using three dry Holstein cows fed alfalfa hay (10 kg/day). Two *in sacco* (2,4,6,8,12,24,48,72 h, and 15,30, 45 min, 2,4,6,8,16,24,48, 72 h) and one intestinal (Incubations: rumen: 16h, acid pepsin-HCl solution: 2.5 h, intestinal digestion: up to 24 h) trials were performed. In both *in sacco* trials six bags/meal were not incubated in rumen and were used to estimate nitrogen soluble fraction which did not differ ($P > 0.05$) for V and VM meals (trial 1: 16 vs 19 %; trial 2: 17 vs 21 %, respectively). Statistical analysis of N disappeared from rumen incubated bags demonstrated no time effects ($P > 0.3$) indicating N disappeared from bags at first incubation time (trial 1: 1 h; trial 2: 15 min). Disappearance values were greater ($P < 0.05$) for VM (25 and 28 %) than for V (14 and 22 %) blood meals, (trials 1 and 2, respectively). Confidence intervals ($\gamma = 95\%$) showed soluble N was not different from rumen N disappeared for V meals, while differences were detected for VM meals. The potentially degradable fraction (b) of the latter meals were 6 and 7 % (trials 1 and 2, respectively); since no time effects were detected, degradation rates were estimated as b/first incubation time (1 h and 15 min), which resulted in 6 and 29 %/h rates. Between processes, differences in intestinal digestibility of undegraded meals N (V: 20 %; VM: 27 %) were not detected ($P > 0.05$). Variation in meals N intestinal digestibility were registered within each process (V: 14 to 33 %, VM: 15 to 60 %). Results indicate blood meals quality may be very variable.

Key Words: Blood Meal, Degradability, Intestinal Digestibility

1360 Ruminal nitrogen release from biuret, urea, and soybean meal. S. J. Bartle*¹, P. A. Ludden², and M. S. Kerley², ¹MoorMan's Inc., Quincy, IL, ²University of Missouri.

The relative ruminal nitrogen release rates of biuret, urea, and soybean meal (SBM) were determined in a replicated 3×3 Latin square experiment. Six Holstein steers (average BW = 702 kg) fitted with ruminal cannulas and jugular catheters were used. Steers were fed a basal diet of 60% soybean hulls, 20% fescue hay, and 20% cottonseed hulls (DM basis) once daily at 1.8% of BW. Experimental periods were 7 d in length. On d 1 to 6, steers were fed the respective nitrogen source and on the 7th day dosing and sampling occurred. In period 1, steers were intraruminally dosed with .25 g/kg BW of urea and isonitrogenous quantities of biuret and SBM. Because of mild symptoms of ammonia toxicity in steers dosed with urea, the dose rate was decreased to the equivalent of .20 g/kg BW of urea for periods 2 and 3. Samples of rumen fluid and blood were collected immediately before dosing (0 min) and at 30, 60, 90, 120, 180, 240, 360, 720, 1080, and 1440 min after dosing. Ammonia was determined in the rumen fluid samples, and ammonia and urea in the serum samples. Ruminal ammonia peaked at 60 to 90 min post dosing. Peak ruminal ammonia levels on the urea treatment were 5 to 8 times greater ($P < .001$) than levels for biuret or SBM. Ruminal ammonia tended to be greater ($P = .10$) for the biuret treatment than the SBM treatment at 30 min post dosing; at later times the biuret and SBM ruminal ammonia levels were similar ($P > .1$). Serum ammonia and urea levels generally followed the patterns observed for rumen ammonia. These results indicate that ruminal nitrogen release from biuret is similar to that from SBM and suggest that nitrogen release rate from biuret did not exceed the ability of the rumen microflora to capture the ammonia.

Sampling time (min)	0	30	60	90	180	360	720
Biuret (mg/dl)	3.8	15.0	15.6	14.0	9.2	2.5	1.0
Urea (mg/dl)	4.0	54.1 ^a	71.3 ^a	78.5 ^a	48.1 ^a	18.5 ^a	2.3
SBM (mg/dl)	4.9	7.8	9.4	10.3	7.9	2.9	1.5

^aUrea levels greater than biuret or SBM ($P < .001$).

Key Words: Biuret, Ammonia, Rumen

1361 Supplemental L-carnitine in growing sheep fed rations containing nonprotein nitrogen. A. M. Chapa¹*, J. M. Fernandez¹, T. W. White¹, L. D. Bunting¹, L. R. Gentry¹, D. T. Hoover¹, D. C. Blouin¹, and S. A. Blum², ¹Louisiana State University, Agricultural Center, Baton Rouge and ²Lonza Inc. Fair Lawn, NJ.

The influence of supplemental L-carnitine was investigated in growing sheep fed rations containing nonprotein nitrogen (NPN). The experiment was conducted as a randomized block design with a 2×2 factorial arrangement of treatments. Lambs (77.4 kg BW, n=23) were fed a total mixed ration with two levels of L-carnitine (0 or 454 g/ton) and two levels of NPN (with urea contributing 0 or 50% of total dietary N) for a 50 d period. Blood samples were collected via jugular venipuncture on days 1, 8, 29, 50 of the experiment at 0, 1, 3 h post-feeding of each day. Ruminal fluid was collected via stomach tube on days 1, 8, 29, and 50 at 1 h post-feeding. Average daily gain (121 vs. 214 g) and G:F ratio (.05 vs .08) were lower ($P < .0001$) in lambs on the NPN diets. Although total feed intake was not different between treatment ($P > .10$), intakes tended to be higher in lambs on Carnitine and NPN ($P = .11$) from day 1 to 7. Lambs consuming diets containing NPN had higher ($P < .0001$) ruminal fluid pH (6.6 vs. 5.9) and ammonia N (4.8 vs. 2.8 mmol/L), and plasma ammonia N (177.1 vs. 49.5 $\mu\text{mol/L}$) compared with lambs not fed NPN. Additionally lambs fed the NPN diets had lower plasma urea N (14.5 vs. 17.5 mmol/L; $P < .003$) and lower plasma thyroxine concentrations (65.8 vs. 78.4 ng/mL; $P < .02$). The T₄:T₃ ratio was also lower ($P < .02$) due to the NPN diets (37.9 vs 43.9). Plasma glucose concentrations were higher ($P < .05$) in lambs fed Carnitine (3.83 vs. 3.70 mmol/L). Production parameters and blood metabolites were affected by NPN incorporation in the diets; however, L-carnitine tended to improve intake early in the experimental period but had minimal effects on blood criteria.

Key Words: L-Carnitine, Sheep, Ammonia

1362 Degradability of forage proteins by in situ and enzymatic methods. W. K. Coblenz*¹, I. E. O. Abdelgadir², R. C. Cochran², J. O. Fritz², and K. C. Olson², ¹University of Arkansas, Fayetteville, ²Kansas State University, Manhattan.

Currently, the in situ procedure, corrected for microbial contaminant N, is one of the most commonly used techniques for evaluating proportions of degradable intake protein (DIP) in forages; however, this procedure is not realistic for commercial use. Recently, some in vitro procedures that utilize the proteolytic enzyme *Streptomyces griseus* (SGP) have shown promise for this purpose. In the first of two studies, alfalfa and prairie hays that had been previously evaluated in vivo for DIP (83.4 and 55.5% of total N, respectively) were incubated in a replicated 3×3 combination of enzyme concentrations (6.6, 0.66, and 0.066 activity units per mL of incubation medium) and incubation times (2, 4, and 48 hours). Two treatment combinations (6.6 activity units for 4 hours and 0.066 activity units for 48 hours) yielded respective DIP estimates for alfalfa (81.4 and 76.8%, SE = 1.1%) and prairie hay (52.3 and 49.4%, SE = 0.9%) that were close to the known in vivo values. In the second study, 20 diverse forages were evaluated in situ for DIP. Forage DIP estimates ranged from 33.1 to 87.8% of total N (SE = 4.3%). Fractional N degradation rates ranged from 1.6 to 13.9% per hour (SE = 1.4%). These forages were also evaluated for DIP by the two SGP procedures identified in the first study, but expanded to include incubation times of 1, 2, 3, 4, and 5 hours at the high SGP concentration and 24, 30, 36, 42, 48, and 54 hours at the low SGP concentration. At the high SGP concentration, the relationship with the in situ method was close ($r^2 \geq 0.898$) for all incubation times; in addition, slopes (range = 0.88 to 1.00) and intercepts (range = -9.4 to 3.5) approached unity and zero, respectively, indicating that direct estimation of DIP concentrations was feasible across a wide range of forages. At the lower SGP concentration, r^2 statistics were still good (≥ 0.81), but slopes (0.59 to 0.67) and intercepts (18.5 to 21.9%) for all incubation times did not meet the respective goals of unity and zero.

Key Words: *Streptomyces griseus* Protease, In Situ, Degradable Intake Protein

1363 Supplemental energy and escape protein for steers consuming annual ryegrass *Lolium multiflorum*. L. Flores*, M. Cervantes, N. Torrentera, J. Rodríguez, and S. Saucedo, ICA, Universidad Autónoma de Baja California, Mexicali.

A latin square (4X4) experiment was conducted to evaluate the effect of supplemental energy (grain sorghum, GS) and escape protein (fish meal, FM) on digestion characteristics of Holstein steers fed fresh annual ryegrass harvested at a vegetative stage. Four steers (250 kg BW) fitted each with two cannulas (proximal duodenum and distal ileum) were used during four 14-d experimental periods. Each period consisted of 9 days of diet adaptation and 5 days of sample collection. Treatments were: T1) ryegrass alone, T2) + 730 g GS, T3) + 350 g FM, and T4) + 730 g GS + 350 g FM. Forage and supplement were offered two times daily (0800 and 1800 h). Intake for treatments T1, T2, T3, and T4 was: DM, 4.94, 5.49, 5.25, 5.95 kg/d; OM, 4.13, 4.75, 4.49, 5.13 kg/d; N, 128, 144, 149, 193 g/d; NDF, 2.06, 2.05, 2.37, 2.58 kg/d, respectively. Duodenal flow for T1, T2, T3, and T4 was: MS, 2.26, 2.60, 3.38, 3.82 kg/d; MO, 1.50, 1.83, 2.29, 2.65 kg/d; N, 90, 110, 173, 185 g/d; NDF, .53, .56, .72, .78 kg/d, respectively. Supplementation of energy or escape protein or both increased consumption and flow of DM, OM, N, and NDF (P<.01). Ruminal digestibility of DM (DMRD) and protein efficiency (PE) for T1, T2, T3, and T4 were: DMRD, 53.7, 52.7, 35.8, 35.4%; PE, .72, .76, 1.14, .96, respectively. Escape protein supplementation decreased DMRD and increased PE (P<.01). Intestinal digestibility, as percentage of duodenal flow for T1, T2, T3, and T4 was: DM, 48.0, 46.8, 49.9, 49.9; OM, 49.6, 48.7, 49.8, 48.6; N, 61.0, 58.4, 66.6, 62.2, respectively. No effect of energy or escape protein was observed on this variable. Total tract digestibility, as percentage of intake was: DM, 81.1, 78.3, 72.6, 73.6; OM, 83.5, 81.0, 76.5, 76.8; N, 79.6, 76.7, 72.3, 74.9; NDF, 76.5, 69.5, 69.9, 69.8, respectively. Escape protein supplementation decreased DM, OM and N digestibility (P<.05). In general, although escape protein supplementation decreased ruminal and total tract digestibility, it increased N duodenal flow without affecting intestinal digestibility. Thus, these data suggest that escape protein supplementation increases the consumption of metabolizable protein by steers grazing annual ryegrass at a vegetative stage.

Key Words: Ryegrass, Escape Protein, Energy

1364 Prediction of laboratory and in situ protein fractions in legume-grass silages using near infrared reflectance spectroscopy. P. C. Hoffman, N. M. Brehm*, J. B. Peters, and L. M. Bauman, University of Wisconsin, Madison.

Legume-grass silage samples (n = 121) were collected from commercial forage testing laboratories (Trial 1). Samples were dried (55°C, 48 h), ground (1mm), and scanned on a model 6500 near infrared reflectance spectro-photometer (NIRS). Laboratory protein fractions (CP, soluble (SOL)-CP, ADF-CP, NDF-CP) were also determined. Sample spectra were centered and 60 samples were selected for calibration development. Terms in the regression (modified partial least squares) and math transformations were varied to yield the best calibration equations. In a second study (Trial 2), legume-grass silages (n = 32) were dried, ground (2 mm), and duplicate dacron bags containing 5 g subsamples were incubated in the ventral rumen of 3 ruminally cannulated cows for 0, 3, 6, 12, 24, 48, 72 h. In situ protein fractions (rapidly degraded (A), slowly degraded (B), undegraded (C)), degradation rate (k_d), and RUP were determined. Original samples were reground (1 mm), scanned, and previously defined NIRS calibration procedures were conducted. Coefficients of determination (R²) and standard errors of calibration (SEC) are presented below. In situ protein fractions were better predicted by NIRS than laboratory protein fractions.

Item	Trial 1		Trial 2	
	R ²	SEC	R ²	SEC
CP, %DM	0.96	0.80	A, %CP	0.96 1.80
SOL-CP, %CP	0.82	4.40	B, %CP	0.96 1.51
ADF-CP, %DM	0.77	0.24	C, %CP	0.92 0.69
NDF-CP, %DM	0.72	0.71	k _d , 1/h	0.87 1.42
			RUP, %CP	0.94 1.23

Key Words: Forage, Protein, Degradation

1365 Intestinal nitrogen and amino acid flow in cows fed diets of different crude protein levels containing soy or feathermeal and bloodmeal supplements. T. R. Johnson*¹, G. M. Anthony¹, P. A. Ludden¹, and M. J. Cecava², ¹Purdue University, West Lafayette, IN and ²Consolidated Nutrition, L. C. Fort Wayne, IN.

Six lactating ruminally and duodenally cannulated cows (BW 510 kg) were used to determine effects of protein source and dietary percentage on intake, digestion, and flow to the duodenum of OM, N, and AA. Treatments were 1. 14% CP (4.5% RUP), 2-4. 16% CP, (5.7%, 6.1%, and 6.7% RUP) and 5. 18% CP (6.5% RUP). Soy protein supplied all supplemental protein in the 14 and 18% CP diets. Hydrolyzed feathermeal and bloodmeal (FTHBM) (3:1 N basis) replaced soy protein in 16% CP diets to create 5.7%, 6.1%, 6.7% RUP diets. All diets contained 35% alfalfa, 15 high moisture corn and supplement. Flows of N and total EAA were not influenced by treatment, however Lysine and Methionine as a percentage of EAA in duodenal digesta were reduced for diets containing FTHBM (P<.05). Proportions of Arginine and Valine were increased by FTHBM feeding (P<.01). Poultry feathermeal and bloodmeal can satisfactorily replace soy proteins in dairy diets but at levels studied in this trial, can significantly change AA profile of duodenal digesta.

Treatment	14%	16%			18%	SE
		low RUP	med RUP	high RUP		
OM intake, kg/d	18.8 ^a	16.8 ^b	17.3 ^a	16.4 ^b	16.9 ^b	.6
N intake, g/d	451 ^a	463 ^a	464 ^a	452 ^a	528 ^b	19
Lys, % of EAA	14.1 ^a	13.7 ^a	13.3 ^b	12.8 ^{bc}	14.0 ^a	.2
Met, % of EAA	5.0 ^a	4.4 ^b	4.5 ^b	4.0 ^c	4.8 ^a	.1
Arg, % of EAA	10.5 ^a	10.8 ^a	10.9 ^a	11.1 ^b	10.5 ^a	.2
Val, % of EAA	12.0 ^a	12.6 ^b	12.6 ^b	13.4 ^c	12.2 ^d	.1
EAA flow, g/d	946	974	1067	882	985	90

^{abcd} Means within rows with unlike superscripts differ (P<.05)

Key Words: Amino Acids, Feathermeal, Protein

1366 Evaluating economic and environmental impacts of overfeeding protein to dairy cows in the Chesapeake Bay drainage basin. J. S. Jonker and R. A. Kohn*, University of Maryland, College Park.

Non-point source N contributes 94.3 million kg of N loading to the Chesapeake Bay annually. The objective was to evaluate the economic and environmental impact of feeding protein according to NRC recommendations compared to current practices for dairy cows (n = 758,347) in the Chesapeake Bay drainage basin. Milk production and composition data obtained from the Lancaster County, PA DHIA from July 1996 through September 1997 was assumed to be representative of all cows in the region. Cows tested for milk urea nitrogen (MUN; n = 98,185) averaged 31.1 kg/day milk, 3.5 % fat, 16.66 mg/dl MUN, and 178 DIM. Excess urinary N excretion was estimated by comparing average MUN levels with target MUN concentrations developed from NRC recommendations when grouping cows by DIM. Seventy-five percent of manure N is typically lost on a dairy farm with 75 % of this loss to water resources. An energy cost of 4.4 kcal NEL/g of N excreted was used to estimate potential milk loss from overfeeding protein. Ground corn was supplemented for soybean meal to estimate excess feed costs. For all economic analyses, milk, ground corn, and soybean meal were \$5.68, \$2.27, and \$5.68 per 100 kg respectively. For a 1-group TMR, the target MUN was 15.55 mg/dl with total costs from excess feed and potential milk loss of \$0.10/d per cow or \$24.0 million annually for all cows in the region. Excess N loading was 2.1 million kg annually representing 2.2 % of the total non-point source N loading to the bay. A 3-group TMR had a target MUN of 14.88 mg/dl with total cost of overfeeding protein of \$38.5 million and an excess N loading of 3.3 million kg annually to the bay. However, many dairy farms maintain high production with lower MUN concentrations than the target indicating a potential for feeding below NRC recommendations and further reducing N loading to the bay. Using MUN as a nutritional tool can help dairy farmers identify when they are feeding excess protein, decrease N loading to the bay and increase profitability.

1367 Evaluating protein requirements predicted by the NRC and a modified version of the NRC. K. F. Kalscheur¹, R. A. Kohn², B. P. Glenn¹, and R. A. Erdman², ¹USDA, Agricultural Research Service, Beltsville, MD, and ²University of Maryland, College Park.

In the 1989 NRC Requirements for Dairy Cattle (NRC) microbial crude protein (MCP) synthesis is a function of the cow's predicted net energy (NEL) requirement. The NRC uses predicted DMI to estimate the metabolic fecal protein (FPA) needed to calculate the absorbed protein (AP) requirement. A modified approach to the NRC (MNRC) is to predict MCP from the NEL available in the diet and to use actual DMI to calculate FPA. The objective of this study was to compare the effect of these different approaches on predicted supply of AP and the predicted allowable milk. Three production studies, each representing a stage of lactation [early (wk 4–14), mid (wk 19–29), and late (wk 34–44)] were used to evaluate each model. Within each experiment, cows were fed one of three corn-based, low CP, isocaloric diets varying only in concentration of ruminally degraded and undegraded protein. NEL (Mcal/kg) used for NRC and MNRC were 1.67 and 1.74, 1.58 and 1.71, and 1.48 and 1.69 for cows in early, mid, and late lactation, respectively. NEL intakes (Mcal/d) used for NRC and MNRC were 36.7 and 37.9, 30.8 and 35.3, and 25.8 and 31.7 for cows in early, mid, and late lactation, respectively. Across all data, the FPA increased 77 g/d and the MCP increased 263 g/d when calculated using the MNRC model compared to the NRC model. The AP predicted requirement was met or exceeded more often using the MNRC than the NRC. Across all data, predicted allowable milk was less than observed for the NRC (0.7 kg, residual error=2.52, RMSPE=2.60) and greater than observed for the MNRC (1.2 kg, residual error=2.76, RMSPE=3.03). In early lactation, when the greatest milk losses occurred for cows fed the low CP diets compared to a high CP control diet, the NRC overestimated the extent of the milk loss (2.8%) and the MNRC was accurate. The NRC would have overfed protein in early and mid lactation, and the MNRC would have met requirements in early lactation but would have been deficient in mid and late lactation.

1368 Meta-Analysis of Nutritional Factors that Affect Milk Protein Yield. I. P. Moloi*, W. K. Sanchez, M. A. McGuire, and B. Shafii, *University of Idaho, Moscow, ID.*

There has been great emphasis on increasing milk protein yield by the dairy producer. Therefore, nutritional factors that affect milk protein were analyzed from 93 dairy nutrition research studies from 1988 to 1997. Missing nutritional data were calculated using the Spartan Ration Evaluator/Balancer for Dairy Cattle so that values for crude protein (CP) and acid detergent fiber (ADF) from Spartan were within 2.5% of the values reported in the research studies. This provided 389 observations with 3295 cow periods from cows producing more than 25 kg milk that were less than 120 days in milk. Principal component analysis was used to identify a list of independent non-correlated variables that explained 75% of the variation among the independent variables. The best 4 principle components included 1) ADF, NDF, NFC, 2) Animal fat, Vegetable fat, 3) UIP, and 4) DIP. Milk protein yield (kg/d) was then regressed upon a subset of these variables, their second and third order polynomials, and possible linear interactions. The best fitting, most parsimonious regression model included DIP, DIP², NDF, NDF², NFC, NFC² and the interaction between DIP and NFC. The predicted regression model was Milk Protein yield (kg/d) = $-1.755003 + 0.328613 \cdot \text{DIP} - 0.007862 \cdot \text{DIP}^2 - 0.051459 \cdot \text{NDF} + 0.000728 \cdot \text{NDF}^2 + 0.083281 \cdot \text{NFC} - 0.000568 \cdot \text{NFC}^2 - 0.003234 \cdot \text{DIP} \cdot \text{NFC}$. The results indicated a curvilinear decrease in milk protein yield as NDF increased. The NFC*DIP interaction revealed that when NFC was high, increasing DIP above the mean content in the database decreased milk protein yield whereas at low NFC, increasing DIP increased milk protein yield. The specified regression equation may be used to estimate the impact of nutritional changes on milk protein yield.

1369 Compartmental modeling to evaluate intra-ruminal ¹⁵N kinetics and determine effects of degree of fat saturation on microbial N recycling. B. S. Oldick and J. L. Firkins*, *Ohio State University, Columbus.*

Two- and 3-compartment (CPT) models were developed to describe intra-ruminal N kinetics in Holstein cattle fed fat varying in degree of saturation. IV of fat sources were 13 (partially hydrogenated tallow; PHT), 51 (tallow; T), or 110 (animal-vegetable fat; AVF). Experimental design, microbial N synthesis (J. Dairy Sci. 79(Suppl. 1):210) and models (J. Dairy Sci. 79(Suppl. 1):137) were described previously. ¹⁵(NH₄)₂SO₄ was dosed into the ruminal NH₃ CPT, and samples were taken over time from the NH₃ and non-NH₃ (NAN) CPT. TCA and ethanol precipitates of NAN were defined as slowly turning over NAN (SNAN); rapidly turning over NAN (RNAN) was determined by difference. SAAMII[®] was used to fit ¹⁵N enrichment curves to models with 2 (NH₃ and NAN) or 3 (NH₃, RNAN and SNAN) CPT. Purines, Cr₂O₃ and Co-EDTA were used to determine pool sizes and fractional rates representing passage to the duodenum for the NAN, RNAN, and SNAN CPT. Because the 3-CPT model predicted bacterial N derived from NH₃ to be unrealistically low (10%; SE=3.0), the 2-CPT model was used to provide measurements of N recycling; all parameters were defined (P<.05) for 15 of 16 data sets. Residuals were serially correlated (P<.05) in 12 of 16 data sets fit to the 2-CPT model. This could be due to an inadequate model or sampling from the same experimental unit over time. Removing ¹⁵NAN values for samples taken 5, 10, and 20 min post dose, when ¹⁵N appeared not to have been adequately mixed, resulted in only 2 of 16 curves having serially correlated residuals and changed (P<.05) only one parameter estimate. N recycling decreased (P<.05) linearly as fat saturation increased {45.2, 50.2, 43.0 and 39.5 % (SE=4.1) for control, PHT, T, and AVF, respectively}. N recycling was not correlated (P>.05) with efficiency of microbial N synthesis or ruminal protozoa counts. However, N recycling tended to be correlated (r=-.49; P=.06) with fluid dilution rate. N recycling was related more closely to fluid dilution rate than to protozoal populations in the rumen.

Key Words: Ruminant, Nitrogen Recycling, Modeling

1370 Alfalfa (*Medicago sativa*) supplementation with proteins of different ruminal degradability in dairy cows. Protein digestion and bacterial synthesis. E. Pavan^{1-2*}, F. J. Santini², and P. V. van Olphen², ¹CIC, *Comisión de Investigaciones Científicas de la Provincia de Buenos Aires*; ² *Unidad Integrada Balcarce (INTA - Fac. Cs. Agrs. UNMdP) (Argentina).*

Four Holstein heifers with ruminal, duodenal and ileal cannulas were used in a replicated Latin square (2x2). Chromic oxid (Cr₂O₅) was used as external marker for digesta flow estimation. Cows were fed three times a day. Diets consisted of fresh alfalfa forage (CP=19.5%, NDF=44.6%, IVDMD=65.5%) offered *ad libitum* and 4.5 kg DM of either rumen degradable (RDP; CP=18%, IVDMD=82.7%) or undegradable protein concentrate (UDP; CP=19.9%, IVDMD=83.8%). Concentrates contained ground corn, wheat bran, salt mix and either sunflower meal (24% of DM; RDP) or fish meal (14%; RUP). Total diet compositions were: OM=91.3 and 90.0%, and CP=18.9 and 19.7% for RDP and RUP respectively. Total OM and CP intake average 10.1 kgOM/d and 2.15 kg CP/d (p>.10). Apparent ruminal OM digestibility was 39.3% of OM intake (p=.34). Although ruminal ammonia concentration was higher (p=.03) when RDP was used (25.3 vs. 19.5 mg/dl), the proportion of total CP reaching the duodenum did not differ with the kind of supplement fed (p=.71) (avg: 98.9% of intake). Duodenal flow (g/d) of nonammonia N (NAN), bacterial N (BN) and dietary N were not different among treatments (avg: 340.2, 267.7 and 78.2). NAN digestibility in the small intestine did not depend on the type of concentrate (p=.96) and its average was 72.2%. Efficiency of bacterial protein synthesis (BPS), as g BN/kg OM apparently or truly digested in rumen, was not affected (p>.10) by treatments (avg: 53.4 and 40.8). Ruminal pH (avg: 6.0) and total VFA concentration (avg: 159.2 mmol/dl) were unaffected by the source of protein used. According to this results, the use of RDP or RUP would not modify either BPS or the total CP arrival to the duodenum in despite of rumen ammonia concentration may be higher with RDP.

Key Words: Sunflower Meal, Fish Meal, Fresh Forage

1371 Influence of liquid methionine hydroxy analogue on digestibility of organic matter of corn-silage and/or concentrate measured in rumen in vitro. J. C. Robert*, V. Ferragu, B. Bouza, and P. E. V. Williams, *Rhône-Poulenc Animal Nutrition, Antony, France.*

The object of two experiments was to measure the effects of DL, 2 hydroxy 4 (methyl thio) butanoic acid (HMB) the liquid hydroxy analogue of methionine (RhodimetTM AT88 : Rhône- Poulenc Animal Nutrition) on the digestibility of organic matter of corn-silage and/or concentrate (% cereals, beet pulp and soybean meal respectively 40, 25 and 25) using a rumen simulation technique (HFT) (Menke et al 1988). Two experiments were carried : 200 mg of dried and ground substrate was incubated with 10 ml of rumen juice plus 20 ml of buffer, in syringes gently agitated at 39°C. Volumes of gas produced were registered at 24 hours. Blank (without substrate), standard hay control and standard concentrate control were used to correct the results and calculate a net volume of gas produced in 24h (Vg). In both trials a factorial design with 7 replicates was used with HMB(H) at two levels (0 or 3 mg and 0 or 9 mg per syringe respectively in the first and in the second trial) and three substrates :corn-silage (S), concentrate (C), corn-silage plus concentrate (1:1 by weight)(SC). In experiment 1, Vg was significantly increased (P<0.001) in the presence of HMB. The effect was significant for S and SC, but not with C. With 9mg HMB, Vg was significantly reduced with S and no significant changes with other substrates. The energy values and OMD of substrates were calculated using Vg and prediction equations proposed by Menke et al (1988). Increase in energy value, (UFL) of S (+ 3 %) and SC (+ 2%) observed with 3mg HMB are sufficient to explain a major part of the increase in milk production obtained in production trials when rations for lactating cows were supplemented with HMB (Rode et al, 1997). However, results obtained with 9mg HMB indicate that the response is sensitive to the quantity of HMB.

Trial	Treatments	S	SH	C	CH	SC	SCH	SED
1	Vg (ml per 200 mg DM)	57.6 ^{d*}	59.9 ^c	62.7 ^{a,b}	63.5 ^a	60.1 ^c	61.8 ^b	0.65
2	Vg (ml per 200 mg DM)	49.1 ^c	47.0 ^d	65.7 ^a	64.2 ^a	56.7 ^b	55.4 ^b	0.51

*a, b, c, d : means in the same line with different superscript are significantly different (p<0.05).

1372 Effect of roasting sunflower meal on rumen fermentation and duodenal N flow in dairy cows. G. E. Schroeder*¹, L. J. Erasmus¹, H. H. Meissner¹, and N. H. Casey², ¹Agricultural Research Council, Irene, South Africa and ²University of Pretoria, Pretoria (South Africa). *Research supported by the Protein Research Trust, Pretoria (South Africa).

The objective of the study was to investigate ruminal fermentation and duodenal N flow in dairy cows fed sunflower meal (SFM), roasted sunflower meal (RSFM) or burnt sunflower meal (BSFM). Three ruminally and duodenally cannulated dairy cows were assigned to a 3 x 3 design and fed a 17% crude protein (as-fed) total mixed diet containing 40% corn, 30% alfalfa hay, 6.25% *Eragrostis curvula* (grass hay), and either 20% solvent-extracted SFM (44% crude protein), SFM roasted at 150°C for 30 min, or SFM roasted at 170°C for 30 min. Milk yield (20.26, 19.17, and 17.66 kg/d, P = 0.40), 4% FCM yields (19.68, 18.63, and 16.79 kg/d, P = 0.13), milk protein (3.39, 3.23, and 3.16%, P = 0.39) and DMI (19.17, 18.46, and 17.13 kg/d, P = 0.42) were lower, and milk fat (3.47, 3.80, and 3.90%, P<0.10) was higher, when cows were fed SFM, RSFM, and BSFM, respectively. However, 4% FCM decreased (P<0.1) and fat % increased (P<0.1), linearly. Roasting probably suppressed DMI and eventually milk yield. Roasting decreased VFA concentrations and ruminal ammonia N. Microbial protein synthesis was reduced, probably due to the lack of ruminally available ammonia. The use of purine concentrations in the urine was a useful tool to compare with the technique using the ratio duodenal N to purine, but overestimated microbial protein synthesis. Increased flow of certain dietary AA compensated for reduced microbial protein synthesis. The flow of Lys to the duodenum was decreased when RSFM and BSFM were fed because of its vulnerability to heat damage. Highly protected protein resulted in reduced microbial protein yield, which supports the concept that sufficient rumen degradable protein and a minimum amount of available ammonia should be present to support microbial growth and fermentation in the rumen.

Key Words: Roasting, Sunflower Meal, Dairy Cows

1373 Effects of micronization on disappearance of amino acids from full-fat canola seed in the gastrointestinal tract of dairy cows. Y. Wang*¹, T. A. McAllister¹, M. D. Pickard², Z. Xu¹, L. M. Rode¹, and K.-J. Cheng³, ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, ²InfraReady Products Limited, Saskatoon, ³University of British Columbia, Vancouver, Canada.

The effect of micronization (an infrared heat treatment) on ruminal and total-tract digestion of amino acids of full-fat canola seed was studied in two *in situ* experiments with three non-lactating ruminally and duodenally cannulated dairy cows. Whole full-fat canola seed (C_W) was hand-cracked (C_H) or micronized for 90 s (M_W). As well, C_W and M_W were ground to pass a 1.25-mm sieve (producing C_G and M_G, respectively). In the first experiment, C_H, M_W, C_G and M_G in nylon bags (80 x 50 mm) were ruminally incubated in the cows for 0, 2, 4, 8, 16, 24, 48 and 72 h. In the second experiment, C_H, M_W, C_G and M_G were sealed into mobile nylon bags (50 x 30 mm), incubated in the cows' rumens for 16 h, treated with pepsin in acid for 1 h, then inserted into the duodenal cannulae for passage through the intestine. Amino acids (AA) in the canola seeds and in the residues from *in situ* incubations were analyzed by HPLC. Micronization reduced (P < .01) ruminal disappearance of both total AA (TAA) and essential (EAA) from full-fat canola seed. Degradation kinetics from Experiment 1 indicated that micronization reduced the soluble fraction and increased the slowly degradable fraction for both TAA and EAA (P < .05). Micronization reduced (P < .05) disappearance of TAA and EAA of whole canola seed in the total digestive tract, but did not affect (P > .05) total tract digestion of TAA or EAA in ground canola seed. Intestinal disappearance of TAA and EAA from both whole and ground full-fat canola seed were increased (P < .05) by micronization. Considered individually, micronization reduced (P < .05) ruminal degradation of the EAA arginine, isoleucine, leucine, lysine and phenylalanine, but increased (P < .05) intestinal disappearance of these AA as well as valine. Micronizing canola seed in rations for high producing animals may be of value in improving AA utilization.

Key Words: Micronization, Full-fat Canola Seed, Amino Acids

1374 Influence of urea or fish meal and solubles in liquid supplement on performance of grazing cow-calf pairs. T. W. White*, D. E. Franke, J. M. Fernandez, G. T. Gentry, L. R. Gentry, P. T. DeRouen, and G. K. Armes, Louisiana State University Agricultural Center, Baton Rouge.

Two experiments were conducted from July 1 to Sept. 23 to evaluate a 2.2% urea (U) or 10% fish meal (Sea-LacTM) and 10% fish solubles (FMS) added to a 16% CP urea-molasses mixture (PM Ag, Inc) to provide 25% CP supplements that were fed in lick wheel feeders to grazing cow-calf pairs. Treatments were: no supplement (NS), U, or FMS for cow-calf pairs and FMS as a creep for calves. In Exp. 1, five cow-calf pairs (three male and two female calves) were assigned to three 2-ha pastures on each treatment. In Exp. 2, two 4-yr-old Hereford x Brahman F1 cows with calves (one male and one female) were assigned to each of six 1-ha pastures on each treatment. In Exp. 1, cows (P<.06) and calves (P<.01) gained more when they had access as pairs to FMS than on the other treatments. In Exp. 2, calf gains were highest (P<.06) when cow-calf pairs had access to FMS. Average daily intake of U and FMS supplements by pairs were 1.71 and 1.68 kg in Exp. 1 and 1.81 and 1.79 kg in Exp. 2. Calves consumed 295 and 245 g/d of FMS creep supplement in Exp. 1 and 2, respectively. Cows fed FMS tended to produce more milk at 28 d (P<.18) and 56 d (P<.11), and the decline in milk production from the initial to 28 and 56 d milkings tended (P<.10) to be less than for other treatments. Plasma ammonia levels were highest (P<.01) in cows fed U. Plasma urea levels of cows and calves were highest (P<.03) when cows were fed U or FMS than when fed NS. Plasma glucose and albumin levels of cows and calves were not affected (P = .12) by treatment. Angus-sired calves were younger than Belgian Blue-sired calves and had higher (P<.01) plasma ammonia levels at 28 d but not at 56 d. Plasma ammonia, glucose, and albumin levels were higher and urea levels lower in calves than cows. These data suggest the benefit of feeding FMS to cow-calf pairs on summer pasture.

Key Words: Cows, Calves, Supplement

1375 Nonenzymatically browned animal tissues for ruminants. C. B. Wilson*, R. A. Mass, R. Lucena, and T. J. Klopfenstein, *University of Nebraska*.

Two experiments were conducted to investigate the effect of sulfite liquor (20% xylose; SL) addition and rendering time on the undegraded intake protein concentration (UIP) of four animal tissues. Experiment I utilized laying hen carcasses (with or without feathers; LHC) and Experiment II utilized pork bones (PB) and pork digestive tract (PDT). Both experiments used the same methods. All tissues were ground and placed in aluminum pans. Treatments were applied in a 3x4 factorial arrangement. Three rendering times at 121°C (60, 90, and 120 min) and four levels of SL (0, 1.5, 2, and 2.5 % of DM) were utilized. Tissues were dried at 60°C for 48 h, extracted using petroleum ether, and ground through a 1-mm screen using a Wiley mill. Analysis of UIP (% of CP) was conducted using in vitro ammonia release. Total tract digestibility was also estimated in Experiment I using a three-step in vitro method. In Experiment I the presence or absence of feathers did not affect UIP of LHC ($P > .05$). Rendering time increased UIP of LHC (65.9% for 60 min vs. 70.2% for 120 min). Addition of SL increased UIP of LHC from the 60.6% UIP of the control. The optimum level of SL observed was 2% of DM (71.3% UIP; quadratic, $P = .05$). The presence of feathers reduced in vitro CP digestibility of LHC (97.0% without feathers, 93.9% with feathers, $P = .0001$). By assuming that feathers are 11.25% of a laying hen's CP, it was calculated that the feathers in LHC are 69.4% digestible (97.0-(3.1÷11.25)). In Experiment II rendering time had no effect on UIP ($P > .05$). Addition of SL increased UIP of both pork tissues from the controls and the controls were different (PB = 63.5%, PDT = 37.3%; $P = .0001$). The UIP of both tissues tended (quadratic, $P = .09$) to be optimized at 2% added SL (PB = 74.8%, PDT = 42.9%). There was a pork tissue by SL interaction ($P = .001$). In conclusion the UIP of LHC was not affected by feathers. However, feathers decreased in vitro CP digestibility of LHC. Addition of SL increased UIP of PB more than PDT.

Key Words: Protein, Rendering, Ruminants

1376 Validation and features of the Mepro dairy ration evaluator. R. A. Patton*, C. J. Peel, W. Heimbeck, and R. Brinkman, *Nittany Dairy Nutrition, Degussa Corporation, Degussa A. G. and Unique Software*.

Mepro dairy ration evaluator (MepE) is a user-friendly, computer program for evaluating dairy rations. MepE was programmed in Visual Basic 3 and runs under Windows 3.x and Windows 95. Data is presented in a spreadsheet format and is easily editable. All major nutrients for lactating cows, dry cows and growing animals are evaluated, including six amino acids: methionine, lysine, leucine, isoleucine, valine and threonine. Requirements for amino acids were developed from a factorial approach using both published literature and Degussa studies and include requirements for maintenance, milk production, body condition repletion, growth and fetal growth during the last 60 days of gestation. Potentially absorbable protein is divided into microbial and rumen undegradable fractions. Microbial protein is predicted from total energy intake, and includes adjustments for lipid, silage and degradable protein intakes. The feed library incorporates the Degussa amino acid data base for all ingredients. It also includes regression equations for feed ingredients based on the crude protein content of the ingredient. For validation, five studies published in JDS (1995-1997) representing 19 diets with amino acid flows and actual consumption were used to compare MepE to CNCPS.

	DMI (kg/day)	Met (g/cow/day)	Lys (g/cow/day)	Leu (g/cow/day)
Actual	20.6 ^a	49.9	165.6	256.1 ^a
CNCPS	18.5 ^b	52.1	159.7	214.8 ^b
MepE	20.2 ^a	50.2	178.7	224.5 ^b
MSE	0.26	1.12	5.09	6.87
LSD*	0.72	3.45	15.6	21.1

^{a, b} Means in the column differ ($P < .05$)

*LSD = Least Significant Difference

We conclude that MepE is sufficiently accurate for routine ration evaluation.

Key Words: Computer Model, Amino Acids

1377 Hepatic phosphoenolpyruvate carboxykinase activity in periparturient and ketotic dairy cows. J. S. Duncan* and D. F. Carroll, *Oregon State University, Corvallis*.

Although the experience of ketosis is a postpartum phenomenon, recent studies have focused on the prepartum period as key in the development of the disorder. Prepartum measurements of energy status, such as low DMI and high NEFA concentrations, have been associated with the development of ketosis. The objective of this study was to evaluate the role of hepatic phosphoenolpyruvate carboxykinase (PEPCK) activity in the onset of ketosis. Tissue specific PEPCK is the rate limiting enzyme of gluconeogenesis in hepatocytes. Thirty-four pregnant multiparous Holstein dairy cows were fed a single prepartum ration that consisted of 50% oat hay, 18% corn silage and 32% grain mix (DM basis). The ration was formulated to meet or exceed NRC requirements of 14% CP and 1.6 Mcal/kg NE_L. At calving, cows were transitioned onto one of two postpartum diets: control (C; n = 13) or 3.5% supplemental fat (F; n = 21). The postpartum diet, fed from 1 to 3 wk, was formulated to be isonitrogenous and to meet NRC requirements. Both diets consisted of 25% alfalfa, 25% corn silage and 50% grain mix. The C and F diets contained 17.2 and 17.6% CP and 1.67 and 1.74 Mcal/kg NE_L, respectively. Livers were biopsied at -14, 2 or 3, and 14 d relative to calving. Tissue samples were analyzed for PEPCK mRNA and activity. In our lab, cows fed the C and F diets on a previous experiment experienced a 25 and 75% occurrence of ketosis. There was no effect of postpartum diet on the occurrence of ketosis, 38.5% and 42.9% for C and F respectively. The high occurrence of ketosis in both diets may be attributed to the rapid transition from the dry cow ration (70:30 forage to concentrate ratio, DM basis) to the lactating cow ration (50:50 forage to concentrate ratio, DM basis). There were no significant postpartum differences by diet in BCS, BW, DMI, βHB, NEFA, or calcium concentrations. Hepatic PEPCK mRNA was not significantly different over time or between cows with and without ketosis. Similar to previous studies, prepartum NEFA concentrations were higher in cows that experienced ketosis when compared to those that did not (458 vs 330 mEq, $P = .18$) as were DMI (1.77 vs 1.69 %BW basis, $P = .20$) and BW (788 vs 743 kg, $P = .08$). Cows that experienced ketosis had lower hepatic PEPCK activity prepartum (6.6 vs 9.3 μmoles/g protein) and postpartum (7.6 vs 10.2 μmoles/g protein) (n = 28, $P < 0.05$). Hepatic PEPCK activity may be a useful prepartum predictor of ketosis susceptibility.

1378 Differences in activity of hepatic microsomal triglyceride transfer protein among species. D. R. Bremmer*, R. R. Grummer, and S. J. Bertics, *University of Wisconsin, Madison*.

Species variation exists in the rate of triglyceride (TG) export from liver. Microsomal triglyceride transfer protein (MTP) is required for very low density lipoprotein (VLDL) assembly and secretion. We hypothesized that some of the variation among species could be explained by differences in hepatic MTP activity. Six species (cow, pig, chicken, rat, guinea pig, and rabbit) were used to compare MTP activity in liver and muscle, hepatic TG accumulation, and the concentration of NEFA in plasma. Mature nonpregnant and nonlactating females were given ad libitum access to diets containing 8% fat. Microsomal fractions from liver and muscle tissue were obtained by homogenization in .25 M sucrose followed by ultracentrifugation. The microsomal fractions containing MTP were incubated for 30 min in the presence of donor and acceptor liposomes and transfer of ¹⁴C-triolein between liposomes was determined. Hepatic MTP activity was greatest in the sow and lowest in guinea pig and rabbit. Hepatic TG was low and only different between the chicken and guinea pig. No differences among species were detected in plasma NEFA. Muscle MTP activity was measured as a negative control and transfer was not detectable. Although there was considerable variation in hepatic MTP activity among these species, there appears to be little relationship between MTP activity and previously published rates for hepatic TG export.

Species	MTP activity ¹ in liver		Liver TG ²		Plasma NEFA (mM)	
	SEM	SEM	SEM	SEM	SEM	SEM
Cow (n=5)	16.5 ^{bc}	1.4	1.7 ^{ab}	0.8	116 ^a	42.3
Sow (n=5)	46.9 ^a	1.4	2.3 ^{ab}	0.8	75 ^a	42.3
Chicken (n=5)	20.7 ^b	1.4	4.7 ^a	0.8	192 ^a	42.3
Rat (n=6)	19.0 ^b	1.3	1.6 ^{ab}	0.7	210 ^a	38.6
Guinea pig (n=6)	10.6 ^d	1.3	1.1 ^b	0.7	169 ^a	38.6
Rabbit (n=6)	11.4 ^{cd}	1.3	1.7 ^{ab}	0.7	74 ^a	38.6

¹%transfer/30 min. ²%DM basis.

^{a, b, c, d} Means within a column not having a common letter differ $P < .05$.

Key Words: Microsomal Triglyceride Transfer Protein, Hepatic Triglyceride, Species Comparison

1379 Changes in activity of hepatic microsomal triglyceride transfer protein in transition cows. D. R. Bremmer, R. R. Grummer*, S. J. Bertics, and S. Besong, *University of Wisconsin, Madison.*

Microsomal triglyceride transfer protein (MTP) is required for very low density lipoprotein assembly and secretion. We hypothesized that MTP activity may increase at parturition and be related to extent of triglyceride (TG) accumulation in the liver of transition cows. Sixteen multiparous and three primiparous Holstein cows were used in an incomplete block design. Liver tissue samples were obtained at 27 d prepartum (d -27), 2 d postpartum (d 2), and 35 d postpartum (d 35) to determine hepatic TG and MTP activity. Data were analyzed as repeated measures using the MIXED procedure of SAS (1996). The effect of time on MTP activity and liver TG was significant ($P < .01$). The MTP activity decreased from d -27 to d 2 and increased from d 2 to d 35. Liver TG increased from d -27 to d 2 and decreased from d 2 to d 35. There was a trend for multiparous cows to have greater MTP activity ($P < .06$) and liver TG ($P < .08$) than primiparous cows (15.3 vs. 12.8% transfer/30 min; 10.1 vs. 6.9% liver TG, respectively). There was no correlation between MTP activity and liver TG (DM basis) in tissue sampled on d 2 ($R = -0.06$, $P = .8$). These results do not support MTP as a factor in the etiology of fatty liver.

	d -27	SEM	d 2	SEM	d 35	SEM	$P < .01^3$
MTP activity ¹	14.5	1.0	12.4	1.0	15.3	0.7	*
Liver TG ²	1.7	1.0	12.7	2.3	11.2	2.7	*

¹%transfer/30 min. ²%DM basis. ³Effect of time on MTP activity and liver TG as determined by repeated measures.

Key Words: Microsomal Triglyceride Transfer Protein, Fatty Liver, Transition Cows

1380 Tallow and grease as sources of supplemental dietary fat for dairy cattle during early lactation. E. J. DePeters*, H. Perez-Monti, S. J. Taylor, J. A. Wyckoff, and R. A. Zinn, *University of California, Davis.*

Forty-seven multiparous Holstein cows were used in an 18-week lactation study. The objective was to determine the effect of fatty acid unsaturation of the supplemental fat on production performance of high producing cows. All TMR contained 45%hopped alfalfa hay and 55% concentrate ingredients including 12% whole cottonseed. The supplemental fats evaluated were tallow and grease. The unsaturated to saturated fatty acid ratio, iodine value, and titer for tallow were 1:1, 46.1%, and 42.8 C and for grease were 2.5:1, 88.7%, and 33.1 C. The Control (C) diet contained no supplemental fat from either tallow or grease. The Tallow (T) diet contained 2% tallow, the Grease (G) diet contained 2% grease, and the Blend (B) diet contained 1.2% tallow and 0.8% grease. Each cow was assigned to the study during the second week of lactation. All cows were fed C during weeks 2 and 3. At week 4, cows randomly were assigned to C, T, G, or B through week 18 of lactation. Week 3 was used for covariate analysis. Production performance was not affected by the addition of supplemental fat or the type of supplemental fat. Milk yield (kg/d), DM intake (kg/d), percentages of fat, protein, and SNF, and milk urea-N (mg/dl) were 40.1, 25.0, 3.6, 3.0, 8.4, 15.0 for C; 42.6, 25.7, 3.7, 2.9, 8.2, 14.7 for T; 43.3, 26.3, 3.6, 3.0, 8.4, 14.7 for G; and 43.6, 26.4, 3.8, 3.0, 8.4, 14.8 for B.

Key Words: Tallow, Grease, Milk Yield

1381 Association of diet induced increases in milk trans fatty acids with the activities of acetyl-CoA carboxylase and fatty acid synthetase in the mammary gland of lactating dairy cows. L. S. Piperova*, B. B. Teter, I. Bruckental, J. Sampugna, and R. A. Erdman, *University of Maryland, College Park.*

A study was undertaken to maximize *trans* fatty acids (tFA) in milk by dietary means and to study activities of acetyl-CoA carboxylase (ACC) and fatty acid synthetase (FAS) and levels of ACC mRNA in the mammary gland of lactating dairy cows. Twelve multiparous Holstein cows in mid lactation were fed a control diet (CT) containing 36% corn silage, 24% alfalfa haylage, and 40% concentrate (DM basis), as TMR for a two week preliminary period. The cows were divided into 2 groups and fed either CT with 0% supplemental fat, or a 75% concentrate:25% corn silage diet supplemented with 5% soybean oil (HCS) in a single reversal design with 2 week experimental periods. Babcock and IR methods were used to measure the milk fat content. Milk fatty acid composition was determined by GC. The activity of ACC and FAS was measured in biopsy samples of mammary tissue, taken during each treatment period. Northern blot analyses were used to determine the ACC mRNA abundance in the mammary gland. The HCS diet reduced milk fat content ($P < 0.001$), measured by both methods. There was a decrease in the milk fat yield ($P < 0.0001$), and no changes in the DM intake, daily milk production, or protein content. The amount of tFA in the milk fat was increased by HCS diet from 1.88% to 15.59% ($P < 0.001$). There was a significant decrease in the milk fat short and medium chain fatty acids ($P < 0.01$), as well as myristic and palmitic acids ($P < 0.001$) when cows were fed HCS diet. The ACC and FAS activity in the mammary tissue of HCS fed cows was depressed by 61% and 54% ($P < 0.001$) compared to the CT group. The reduced ACC mRNA abundance in the mammary tissue is consistent with decreased ACC and FAS enzyme activity and may account for the depressed activities observed. These results suggest that increased tFA availability in the mammary gland inhibits *de novo* fatty acid synthesis.

Key Words: *Trans* fatty acids, Acetyl-CoA Carboxylase, Fatty Acid Synthetase

1382 Dose-response to increasing amounts of high-oleic sunflower fatty acids infused into the abomasum of lactating dairy cows. T. R. Overton¹, A. D. Beaulieu*¹, J. Zhu¹, G. Ortiz-Gonzalez¹, J. K. Drackley¹, and D. M. Barbano², ¹*University of Illinois, Urbana;* and ²*Cornell University, Ithaca, NY.*

Four multiparous Holstein cows were utilized in a crossover design and abomasally infused with increasing amounts (0, 250, 500, 750, and 1000 g/d) of fatty acids from high-oleic sunflowers (HOSFA). Continuous infusions (20 to 22 h/d) were for 7 d at each amount. Infusions were homogenates of HOSFA with 240 g/d of meat solubles and 11.2 g/d of Tween 80. Controls were infused with carriers only. The HOSFA contained (by weight) 2.4% C16:0, 1.8% C18:0, 91.4% cis-C18:1, and 2.4% C18:2. The DMI decreased linearly (range 21.8 to 5.2 kg/d; $P < .001$) and yields of milk (27.2 to 6.6 kg/d), fat, CP, true protein, casein, NPN, and total solids decreased quadratically ($P < .02$) as the amount of HOSFA increased. Decreases in yields of milk and milk components were most pronounced at the 750 and 1000 g/d infusions. Percentages of milk fat (3.29 to 5.96%) and total solids (12.02 to 14.17%) were increased quadratically ($P = .001$) as the amount of HOSFA increased. The contents of short-chain fatty acids (FA), C12:0 (4.52 to 1.28 g/100 g of FA), and C14:0 (12.72 to 4.36 g/100 g of FA) in milk fat decreased linearly ($P < .001$) as the amount of HOSFA increased. The content of cis-C18:1 (19.94 to 58.59 g/100 g of FA) in milk fat increased linearly ($P < .001$) as the amount of HOSFA increased. The volume mean diameter of milk fat droplets (2.98 to 4.03 μm), along with the diameter below which 90% of the volume of milk fat is contained (5.16 to 6.96 μm), increased linearly ($P < .001$) as HOSFA infusion increased. These data indicate that composition and physical characteristics of milk fat can be altered markedly by increased availability of cis-C18:1, which could have important implications for processing characteristics and healthfulness of milk fat.

Key Words: Fatty Acids, Dairy Cows, Milk Fat

1383 Transfer of omega-3 linolenic acid from flaxseed to milkfat. J. Goodridge* and J. R. Ingalls, *University of Manitoba, Canada.*

Two experiments were conducted to determine the effects of supplemental ground flaxseed, protected either with formaldehyde or lignosulfonate and heat, on the linolenic content of milkfat. Linolenic acid (C18:3), an omega-3 fatty acid, comprises approximately 55-60% of the total fatty acids in flaxseed with a similar level of C18:2 in Linola (Solin). Four midlactation cows were used in a Latin Square design with 21 day periods. In the first experiment a TMR was supplemented with i) no fat, ii) protected Linola - 454g of fat, iii) protected flax -454g of fat, iv) protected flax -410g of fat. The Linola and flaxseed were treated with formaldehyde by J.R. Ashes, CSIRO, Australia. Feed intake, milk yield and composition (% fat, protein, SNF), rumen ammonia, volatile fatty acids and plasma urea nitrogen were not influenced by diet (P>0.05). As indicated below linoleic acid in milkfat was increased (P<0.05) by supplemental protected Linola while linolenic acid was increased by protected flaxseed. The second experiment was similar in design to experiment 1. Diets consisted of TMR top dressed with i) no fat, ii) protected flax - 354g of fat iii) ligno-flax - 170g of fat and iv) ligno-flax - 327g of fat. Flaxseed was treated with lignosulfonate by EXL Milling (Hassall, Sask.), ground and heated to 155°C and steeped for 30 minutes at a beginning temperature of 124°C and an end temperature of 118°C. Linolenic acid in milk was not significantly affected by the lignosulfonate plus heat treated flax. Milk C18:3 was significantly greater in cows receiving formaldehyde protected flax. Daily yield of linolenic acid in the two experiments was increased by 770-790% with the feeding of protected flax product. If properly protected from biohydrogenation in the rumen, flaxseed offers an opportunity to substantially improve C18:3 in milk or C18:2 in the case of Linola.

Trail	Control	Linola	Flax Low	Flax High	Flax Exp 2
Milk fat (kg)	.87	1.04	.96	.98	.96
% C18:2	4.8 ^d	10.3 ^a	6.0 ^c	6.9 ^b	6.0
% C18:3	0.8 ^c	1.0 ^c	3.7 ^a	6.4 ^a	3.5

Key Words: Flaxseed, Linola, Linolenic Acid

1384 Production and feed intake of cows fed diets high in omega-3 fatty acids from unprotected and ruminally protected algae. S. T. Franklin*, D. J. Schingoethe, and R. J. Baer, *South Dakota State University, Brookings.*

A diet for cows rich in omega-3 fatty acids from marine algae (Omega Tech, Inc., Boulder, CO) may help improve the nutritional value of milk fat, however, effects on production and DMI are unknown. Therefore, 30 cows (9 Brown primiparous Brown Swiss and 21 multiparous Holsteins) were assigned to a control diet (1), a diet supplemented daily with 910 g of ruminally protected algae (2), or a diet supplemented daily with 910 g of unprotected algae (3). Diets 2 and 3 provided approximately 90 g of docosahexaenoic acid (22:6, n-3) daily. Cows were housed in a free-stall facility and fed individually using Calan gates. All cows received the control ration during wk 1 of the trial. The amount of protected and unprotected algae added to TMR diets 2 and 3 was increased gradually during wk 2 until cows were receiving 910 g of algae daily. Milk production was recorded for each milking and feed fed and refused were recorded daily for 6 wk. Fat percentage and yield were lower (P < 0.05) for cows fed algae. Dry matter intake, milk production, protein percentage and yield, body weight, and body condition score were not affected (P > 0.05) by diet. Algae high in omega-3 fatty acids can be an adequate nutritional component of diets for dairy cows.

Item	Diet 1	Diet 2	Diet 3	SE
Milk, kg/d	23.2 ¹	23.5	23.0	0.7
ECM, kg/d	22.9	21.5	20.5	0.9
Fat, %	3.61 ^{a2}	2.91 ^b	2.89 ^b	0.10
Fat, kg/d	0.81 ^a	0.68 ^b	0.64 ^b	0.04
Protein, %	3.11	3.05	2.98	0.05
Protein, kg/d	0.71	0.70	0.67	0.03
DMI, kg/d	20.6	20.0	19.1	0.6

¹ Values are presented as covariate adjusted least squares means. ² Within a row, values with different superscripts are different (P < 0.05).

Key Words: Omega-3 Fatty Acids, Algae, Milk Fat

1385 Milk yield and composition during abomasal infusion of conjugated linoleic acid in dairy cows. P. Y. Chouinard*, L. Corneau, D. E. Bauman, L. E. Metzger, and D. M. Barbano, *Cornell University, Ithaca, NY.*

Conjugated linoleic acid (CLA) refers to a series of positional and geometric isomers of linoleic acid that has been reported to inhibit carcinogenesis in experimental animal models. We examined the effect of CLA on milk yield and composition by abomasal infusion of a commercially available mixture of CLA isomers (CLA-60; Natural Lipids LTD, Hovdebygd, Norway). The CLA mixture contained 61.2% CLA and the major isomers were 14.5% c/t-9,11, 9.3% c/t-8,10, 10.6% c/t-11,13, and 21.2% c/t-10,12. Four levels of CLA-60 mixture (0, 50, 100 and 150 g/d) were infused continuously over a period 5 d followed by 4 d of washout in a 4 x 4 Latin square. Data from day 4 and 5 of the infusion periods were used for statistical analysis. CLA-60 infusions had no effect on DMI but milk yield decreased linearly with the amount of CLA infused. Infusion of CLA-60 resulted in a dramatic reduction of milk fat concentration, and the milk fat depression was already maximized at the lowest level of infusion. Transfer efficiencies of the infused CLA isomers (amount excreted in milk fat/amount infused) were 22.0%, 21.6%, 25.8%, and 10.3% for c/t-9,11, c/t-8,10, c/t-11,13, and c/t-10,12, respectively. These data suggest that the c/t-10,12 isomer is transferred less efficiently or is more extensively metabolized.

CLA-60 infused (g/d) ¹	0	50	100	150	SEM
Milk yield, kg/d	21.5	20.4	20.9	18.3	0.84
Fat, %	2.81	1.43	1.38	1.23	0.12
CLA, mg/g milk fat					
c/t-9,11	5.4	9.5	15.2	19.1	0.8
c/t-8,10	0.1	2.7	7.8	11.4	0.6
c/t-11,13	0.3	3.5	11.0	16.4	0.8
c/t-10,12	0.2	3.1	8.2	11.3	0.5

¹ Linear effect for milk yield (P < 0.05) and CLA concentrations (P < 0.01); linear (P < 0.01), quadratic (P < 0.01), and cubic (P < 0.05) effects for milk fat test.

Key Words: Conjugated Linoleic Acid, Milk Fat

1386 Conjugated linoleic acid content of milk from cows fed extruded oilseeds. T. R. Dhiman^{1*}, E. D. Helmink¹, D. J. McMahon¹, R. L. Fife¹, and M. W. Pariza², ¹Utah State University, Logan, ²University of Wisconsin, Madison.

Twenty-four cows were used to study the influence of feeding extruded oilseeds on conjugated linoleic acid (CLA) content of milk and cheese. Cows were assigned to three treatments and fed diets containing forage and grain in 47:53 ratio. Diets contained either soybean meal (13.5% of DM; CTL), full fat extruded soybeans (12% of DM; ESB) or full fat extruded cottonseed (12% of DM; ECS). Diets contained 2.73, 4.89 and 4.56% of fatty acids in CTL, ESB and ECS treatments, respectively. Experimental period was 8 wks. Measurements were made during the last 5 wks of the experiment. Daily DMI and milk yields were recorded. Once a week milk samples were analyzed for composition and fatty acid profile. During wk 7 and 8 of the experiment, milk samples (10 kg) from individual cows were processed into Mozzarella cheese. Cheese samples were analyzed for fatty acid profile. Results are summarized below:

Item	CTL	ESB	ECS	SEM	P
DMI, kg/d	23.4 ^b	25.8 ^a	25.8 ^a	1.9	0.02
3.5% FCM, kg/d	30.9 ^b	36.7 ^a	35.3 ^a	2.8	0.01
Fat, %	3.61	3.18	3.31	0.06	0.09
Protein, %	3.25	2.98	3.00	0.03	0.08
Milk CLA, mg/g of fat	3.4 ^c	6.9 ^a	6.0 ^b	0.2	0.01
Cheese CLA, mg/g of fat	3.4 ^c	7.3 ^a	6.0 ^b	0.3	0.01

Dry matter intake and 3.5% FCM yield were higher for cows in ESB and ECS treatments compared with CTL. Most of the long-chain fatty acids and CLA were increased in milk and cheese from cows in ESB and ECS treatments compared with CTL. Processing of milk into cheese did not alter the CLA content. Conjugated linoleic acid content of milk and cheese can be increased by feeding full fat extruded soybeans and cottonseed to dairy cows.

Key Words: Conjugated Linoleic Acid, Milk, Fat

1387 Net flux of metabolites across the portal-drained viscera and liver of pregnant ewes. H. C. Freetly* and C. L. Ferrell, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

It was the objective of this study to determine the pattern of nutrient flux across the portal-drained viscera (PDV) and liver during pregnancy. Catheters were placed in the hepatic portal vein, a branch of the hepatic vein, a mesenteric vein, and the abdominal aorta of ewes. Blood flow and net nutrient release across the PDV and liver were determined prior to breeding. After mating, two ewes were not pregnant, six ewes had single, and 11 ewes had twin fetuses. Measurements were taken 103, 82, 61, 39, 19, and 6 d before parturition. Net PDV glucose release did not differ from zero (-4 ± 8.4 mmol/h; $P = .58$). Net hepatic glucose release in ewes with twin (40.3 ± 1.3 mmol/h) and single (36.8 ± 1.4 mmol/h) fetuses tended to be higher than in nonpregnant ewes (26.9 ± 1.8 mmol/h; $P = .08$). Net PDV lactate release (9.7 ± 4.6 mmol/h) did not differ with litter size ($P = .58$) or days from parturition ($P = .14$), but net lactate uptake by the liver increased as the pregnancy progressed ($P < .001$). The hepatic extraction ratio for lactate increased in late pregnancy ($P = .02$). Net PDV release of acetate (155.6 ± 50.7 mmol/h), propionate (42.2 ± 15.9 mmol/h), 2-methyl-propionate (1.66 ± 1.18 mmol/h), and valerate ($.9 \pm 1.2$ mmol/h) were not different with litter size ($P > .27$) or days ($P > .26$) from parturition. Net hepatic acetate uptake (-4.3 ± 35.5 mmol/h) did not differ from zero ($P > .11$). Net hepatic uptake of propionate (38.6 ± 13.9 mmol/h), 2-methyl-propionate ($1.73 \pm .84$ mmol/h), and valerate (1.1 ± 1.2 mmol/h) were not different with litter size ($P > .52$) or days from parturition ($P > .09$). This study suggests that net hepatic lactate uptake and glucose release increase as pregnancy progresses in the ewe.

Key Words: Sheep, Metabolism, Blood Flow

1388 Effects of ruminally degraded nitrogen and abomasal essential amino acid infusion on energy and nitrogen balance and visceral heat production. C. R. Krehbiel*¹, C. L. Ferrell², H. C. Freetly², and J. A. Neinaber², ¹*New Mexico State University, Las Cruces, and* ²*USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Seven steers with portal and hepatic catheters were used in a 6 x 6 Latin square design to determine the effects of feeding different amounts of ruminally degraded nitrogen (RDN) and increasing postprandial infusion of essential amino acids (EAA) on energy balance, N balance and net portal and hepatic consumption of oxygen. Treatments consisted of an unsupplemented (9.5% CP; LP) or urea supplemented (12.5% CP; HP) high-corn diet (92.5% concentrate) with abomasal infusion of 0, 90, or 180 g of EAA/d. Experimental periods lasted 14 d. Dietary adaptation was from days one through nine, and adaptation to infusion of EAA or water was from days three through nine. On d 10, simultaneous arterial, portal, and hepatic blood samples were taken five times at 1.5-h intervals. Total urine and feces were collected from d 11 through 14. On d 12 or 13, O₂ consumption, and carbon dioxide and methane production were determined using respiration boxes. Arterial O₂ concentration was greater ($P = .07$) when HP was fed compared with steers fed LP. Portal-drained visceral and liver O₂ consumption were not affected ($P > .10$) by increasing RDN or EAA. However, total splanchnic O₂ consumption increased (quadratic, $P = .04$) as EAA infusion increased. Dry matter intake, gross energy intake, ME, and HP were not affected by RDN or EAA. Fecal energy was 26% lower ($P = .08$) and DE was 6% greater ($P = .14$) in steers fed HP compared with steers fed LP. Retained energy decreased as EAA infusion increased when LP was fed, and increased as EAA infusion increased when HP was fed (RDN x EAA interaction, $P = .05$). Total N intake and retained N were greater ($P = .01$) when HP was fed compared with controls and increased as EAA infusion increased ($P = .02$). Increasing postprandial supply of EAA results in an increased retention of tissue N and energy.

Key Words: Ruminants, Ruminally Degraded Protein, Amino Acids

1389 Milk protein production in cows subjected to abomasal infusion of branched-chain amino acids (BCAA) and a hyperinsulinemic-euglycemic clamp. E. L. Annen^{1*}, M. A. McGuire¹, T. W. Hanson¹, and D. E. Bauman², ¹*University of Idaho, Moscow,* ²*Cornell University, Ithaca, NY.*

Milk protein yield is dramatically enhanced by elevated insulin and additional dietary protein (casein) supplied post-ruminally. Uptake of BCAA (leucine, isoleucine, valine) is in excess of uptake of all other essential amino acids (EAA), and BCAA represent 50 % of the EAA in milk protein. We hypothesized that milk protein production, particularly when stimulated by insulin, could be enhanced further by supplemental BCAA. Four lactating, Holstein cows were subjected to abomasal infusion of BCAA and a hyperinsulinemic-euglycemic clamp. The study was arranged in a 2x2 crossover design with 12 d periods, which included adjustment, baseline, and clamp phases (each 4 d). The two periods consisted of abomasal infusion of BCAA (42 g leucine, 21 g isoleucine, and 24 g valine per day) or water (6.2 L/d). Cows were fed frequently to minimize postprandial effects. Blood samples were taken via indwelling catheters every 6 h for 4 d to determine baseline glucose concentrations. During the 4 d clamp insulin was infused intravenously at a rate of $1 \mu\text{g} \cdot \text{kg} \cdot \text{BW}^{-1} \cdot \text{h}^{-1}$ in order to elevate circulating insulin 5-fold. Blood was sampled frequently and infusion of exogenous glucose was adjusted to maintain glucose levels within 10% of baseline concentration. Milk yield, protein%, fat%, and feed intake were unchanged due to BCAA or insulin. Further, no BCAA x insulin interaction for any variable was detected. We conclude that BCAA alone are unable to enhance milk protein production in the normal environment or during elevated insulin. Thus, other EAA must be required to support milk protein production.

	H ² O		BCAA	
	-INS	+INS	-INS	+INS
Milk, kg/d	26.9	27.0	26.1	24.5
DMI, kg/d	20.1	18.9	19.7	16.5
Protein, %	3.29	3.25	3.18	3.28
Fat, %	4.06	3.54	4.13	4.00

Key Words: insulin, branched-chain amino acids,

1390 Growth, estimated carcass fatness and insulin secretion in beef cattle offered rations which differed in starch form and concentration. A. P. Moloney*, M. J. Drennan, and P. Shiels, *Teagasc, Grange Research Centre, County Meath, Ireland.*

The objectives were to determine the effects of processing and starch concentration in high concentrate rations on growth, carcass fatness and insulin secretion in beef cattle. Sixty Friesian bulls (initial body-weight (BW) 401 kg), were penned in pairs and offered *ad libitum* one of 3 ground and pelleted rations containing 139, 239 or 327 g starch/kg dry matter (DM), a coarse ration based on rolled barley, corn gluten and sugar beet pulp (311 g starch/kg DM) or a coarse ration based on rolled barley and soyabean (492 g starch/kg DM). Prior to slaughter after 19 wk, urea space was measured by urea dilution and ribeye area and fat cover by ultrasound. In a parallel study, using Friesian steers (n=6/treatment), blood samples were collected before (n=8; -4.5 to 0 h) and after (n=12; 0 to +2 h) intravenous injection of 200 mg glucose/kg BW. Daily DM intake, carcass growth and area under the insulin response curve were 15.4, 15.9 and 13.9 (sed 0.50) kg/pair, 594, 646 and 568 (sed 47) g/day and 3467, 1820 and 2042 (sed 990) $\mu\text{U} \cdot \text{min}/\text{ml}$ in cattle offered rations 139, 239 and 327, respectively. At similar starch concentration, grinding decreased ($p < 0.05$) daily DM intake (17.3 v 13.9 kg/pair), carcass growth (685 v 568 g/day) and increased ($p < 0.05$) urea space (446 v 517 ml/kg BW). Increasing rolled starch concentration increased ($p < 0.05$) basal glucose concentration (4.59 v 4.20 mmol/l). There were no other treatment effects on carcass fatness or blood variables. It is concluded that (1) grinding decreases the starch inclusion level for optimum growth of beef cattle offered high concentrate rations and (2) an increase in ground but not rolled starch concentration decreases the insulin response to a glucose challenge.

Key Words: Beef Cattle, Starch, Insulin

1391 Abomasal carbohydrate availability and net splanchnic metabolite flux in lambs. A. F. Branco*, D. L. Harmon, C. J. Richards, K. C. Swanson, B. T. Larson, S. J. Lewis, and D. W. Bohnert, *University of Kentucky, Lexington.*

Eight multicatheterized wethers (38 kg) were used in a replicated 4 × 4 Latin square design to study net uptake and release of plasma metabolites across the portal-drained viscera (PDV), hepatic (HEP) and total splanchnic (TS) tissues in response to abomasal infusion of carbohydrates. Lambs consumed 925 g/d of a ground fescue hay and soybean meal diet in 2 portions. The diet supplied 1.4 × NEM requirements and contained 20.2% CP. Treatments were: abomasal infusion of glucose (G), Satin Sweet® (65% maltose, 15% maltotriose; M), starch hydrolysate (SH) and raw starch (RS). Lambs received 2.5 g/h for 2 d and 5.0 g/h for 7 d with blood sampling on d 9. Treatments were compared using the following contrasts: G vs. M, G+M vs. SH and SH vs. RS. No differences were measured (P > .10) in portal, hepatic and arterial plasma flows or concentrations of alpha-amino N (AAN) and urea N (UN). Portal, hepatic and arterial glucose concentrations were greater (P < .05) for SH compared with RS (3.96 vs. 3.67; 4.10 vs. 3.87; 3.82 vs. 3.63 mM, respectively). Portal, hepatic and arterial lactate concentrations were less (P < .01) for SH compared with RS (.697 vs. .919; .668 vs. .916; .600 vs. 0.839 mM, respectively). Net PDV glucose flux was greater (P = .02) for SH compared with RS (13.19 vs. 3.29 mmol/h). Net PDV lactate flux was greater (P = .07) for SH compared with G+M (8.61 vs 6.87 mmol/h). Infusion of SH resulted in a net HEP lactate uptake (-1.27 mmol/h) and RS infusion resulted in a net HEP lactate release (1.15 mmol/h; P < .01). TS lactate flux was less (P = .09) for SH compared with RS. Net PDV, HEP and TS flux of AAN and UN were not different (P > .10). A net removal of lactate by the liver was observed with SH infusion and a release with RS (P < .01). Results indicate there are advantages in the digestion and absorption of SH, and that physical structure of the starch affects net PDV glucose flux.

Key Words: PDV, Metabolite Net Flux, Carbohydrate

1392 Nocturnal grazing and supplementation effects on forage intake and weight changes of cattle. A. A. Ayantunde¹, S. Fernández-Rivera*¹, and M. Chanono², ¹*International Livestock Research Institute, Niamey, Niger*, ²*Ministère de l'Agriculture et l'Élevage, Toukounous, Niger.*

Sixty-four Azawak male calves (BW=224 kg, SD=58 kg) were used to study the effect of nocturnal grazing (NG) and supplementation (SUP) on forage intake, feeding behavior and weight changes of cattle. Treatments were factorial combinations of four levels of NG (0, 2, 4 and 6 h/d) and two levels of SUP (0 and 605 g DM millet bran animal⁻¹ d⁻¹). All calves were allowed to graze 10 h during the day and were weighed every 2 wk during 70 d. Feces were collected during 9 d from all animals. Eating time was determined in four animals per treatment by recording animals' activities every 5 min during 8 d. Eight steers fitted with esophageal cannulas were randomly divided in two groups (with and without SUP) and used in a cross-over design for sampling diet forage. Both groups grazed 10 h during the day and 4 h at night. Extrusa CP (64 vs 68 g/kg DM, SEM=3) and in vitro OM digestibility (480 vs 473 g/kg, SEM=11) as well as time spent eating in the day (310 vs 307 min/d, SEM=2) or at night (97 vs 96 min/d, SEM=1) were not influenced by SUP (P>.05). Total (day-and-night) eating time increased 39.4±2.3 min/h NG and decreased 1.9±.4 min/h² NG. In non-supplemented calves forage intake (SEM=2.2) was 59.3, 62.9, 68.0 and 69.4 g OM kg BW^{-0.75} for 0, 2, 4 and 6 h of NG, respectively, whereas in supplemented animals it was 61.5, 61.9, 64.9 and 64.0 g OM kg BW^{-0.75} for 0, 2, 4 and 6 h of NG, respectively. In non-supplemented cattle ADG increased 24.4±8.7 g/h NG, whereas in supplemented animals ADG increased only 9.3±6.2 g/h NG. The response in ADG tended to decrease with more than 4 h of NG. Supplementation improved ADG (-107 vs 99 g/d, SEM=14, P<.01). Supplementation does not affect quality of diet selected or eating time but substitutes forage consumption at long periods of night grazing. Night grazing improves dry season performance and its effect decreases if cattle are supplemented.

Key Words: Cattle, Forage Intake, Grazing

1393 In vitro and in situ digestion and dry matter intake of bermudagrass cultivars harvested at different stages of maturity. P. Mandevbu*¹, G. M. Hill¹, J. W. West¹, and R. N. Gates², ¹*University of Georgia*, ²*USDA-ARS, Georgia.*

Three paddocks (0.81 ha each) of Tifton 85 (T85) and of Coastal (CBG) bermudagrass were harvested at 3, 5 or 7 wk in summer of 1997 for hay which was then fed to 36 individually penned growing beef steers (243.8 kg average BW) for ad libitum intake without protein or energy supplement. *In vitro* dry matter disappearance at 48 h of incubation with subsequent acid pepsin digestion for an additional 48 h (IVDMD) and *in situ* DM disappearance (ISDMD) were determined. Total potentially digestible fraction (PDF) and rate of digestion (Rate) were calculated by fitting *in vitro* NDF disappearance (IVNDFD) data at 3, 6, 12, 24, 36, 48, 72 and 96 h of incubation to the nonlinear equation $p=a+b(1-e^{-ct})$.

Item	Cultivar (C)			Maturity (M), wk			
	T85	CBG	SE	3	5	7	SE
CP, % DM	14.3 ^a	14.5 ^a	0.1	15.3 ^a	15.1 ^a	12.8 ^b	0.1
NDF, % DM	75.1 ^a	70.9 ^b	0.2	72.9 ^b	75.2 ^a	71.0 ^c	0.3
IVDMD at 48 h, %	63.2 ^a	59.4 ^b	0.2	62.7 ^a	60.5 ^b	60.7 ^b	0.3
IVNDFD at 96 h, %	74.0 ^a	68.2 ^b	0.4	72.7 ^a	72.6 ^a	68.0 ^b	0.5
IVNDFD-PDF, %	76.0 ^a	69.0 ^b	1.7	74.8 ^a	74.7 ^a	68.0 ^b	2.6
IVNDFD-Rate, %/h	4.5 ^a	4.2 ^a	0.2	4.4 ^{ab}	4.0 ^b	4.9 ^a	0.4
ISDMD at 96 h, %	74.3 ^a	67.8 ^b	1.0	74.6 ^a	71.3 ^a	67.3 ^b	1.3
DMI, kg/d	4.7 ^a	4.8 ^a	0.1	4.6 ^b	4.6 ^b	5.0 ^a	0.1

^{a,b,c}Means with no common superscripts within a row within C or M differ (P < 0.05). C × M interaction (P < 0.05) was observed for CP only.

Although T85 had 4.2% higher NDF concentration than CBG, it had 3.8% higher IVDMD, 5.8% higher IVNDFD at 96 h, 7.0% higher PDF of NDF, and 6.5% higher ISDMD at 96 h than CBG. Digestibility of bermudagrasses decreased with increase in maturity. It is concluded that T85 is more digestible than CBG at similar stages of maturity, and cultivar had no effect on DMI.

1394 Effects of using a high fiber corn silage over conventional corn silage on performance of growing steers. C. J. Mueller*, R. H. Pritchard, and Z. W. Wicks, III, *South Dakota State University, Brookings.*

A 70-d growing steer trial along with harvesting data were used to evaluate the production performance of a high fiber silage variety (CSV1) versus a conventional corn silage variety (CSV2). Varieties were harvested over 2 d as chopped whole plants and allowed to ferment for 52 d in bunker silos. CSV1 yielded 41.0 T/ha (29.3% DM), while CSV2 yielded 36.0 T/ha (28.0% DM). Diets containing 88.6% corn silage and 11.4% pelleted supplement (DM basis) were fed to 160 steer calves. Calves were blocked by initial BW into light (234 ± 3.2 kg) and heavy (270 ± 4.4 kg) groups. There were 10 pens of steers assigned to each treatment. Steers were implanted with Ralgro and fed once daily. Final BW included a 3% shrink. Pens were considered the experimental unit. Ingredient samples were collected weekly and analyzed. The CP, starch, NDF, ADF, and lignin composition of silages differed (P < .01). Digestibilities measured by IVDMD were similar between varieties. Calculated NE_g values using ADF content differed (P < .001) between varieties (1.05 Mcal/kg vs 1.13 Mcal/kg for CSV1 and CSV2, respectively). The NE_g (1.09 Mcal/kg vs 1.16 Mcal/kg for CSV1 and CSV2, respectively) values calculated from steer performance were also different (P < .05) between varieties. Correcting G/F to 100% corn silage and multiplying by harvest yield/ha (DM basis) resulted in CSV1 producing 2284 kg of beef/ha compared to 2026 kg of beef/ha produced by CSV2. Similar calculated energy values illustrate the possibility of using proximate analysis to evaluate caloric density. These data indicate limitations in selecting a variety based on a sole characteristic, such as proximate analysis or yield.

Trt	CP,	Starch,	NDF,	ADF,	Lignin,	IVDMD,	ADG,	DMI,	G/F
	%	%	%	%	%	kg	kg		
CSV1	7.4	18.7	43.3	24.1	5.7	69.2	1.04	6.22	.168
CSV2	6.9	30.2	38.6	20.2	4.6	69.2	1.09	6.12	.178
SEM	.012	.038	.032	.010	.007	.028	.003	.015	.0004
P =	.001	.001	.001	.001	.001	NS	.0965	NS	.0195

Key Words: Beef, Corn Silage, Feedlot

1395 Enhanced NDF digestibility of corn silage did not decrease physical effectiveness of NDF. M. Oba and M. S. Allen*, *Michigan State University, East Lansing.*

Effects of enhanced NDF digestibility of corn silage on chewing activity and ruminal kinetics of NDF were evaluated using 8 multiparous ruminally cannulated dairy cows (70 DIM) in a duplicated 4 x 4 Latin square design. Experimental diets consisted of either brown midrib (bm3) corn silage or its isogenic normal control at two levels of dietary NDF (29% and 38%). In vitro NDF digestibility at 30h was higher for bm3 corn silage by 9.4 units. Feeding behavior of animals was monitored continuously for 4 days each period by a computerized data acquisition system. Rumens were evacuated twice per period to determine the ruminal NDF pool and its turnover time. There was no effect of NDF digestibility on total chewing time either per day or per kg of NDF intake, or on ruminating time either per day or per kg of NDF intake. Although high NDF digestibility decreased turnover time of NDF in the rumen, it increased DMI and had no effect on ruminal NDF pool size. Total chewing time and ruminating time per day were positively related to NDF intake ($r > 0.55$) and ruminal NDF pool size ($r > 0.49$), but not related to ruminal turnover time of NDF. These results provide no evidence that enhanced NDF digestibility decreases the physical effectiveness of NDF of corn silage.

	Low NDF		High NDF		NDF	P value FD	NDFxFD
	HFD	LFD	HFD	LFD			
DMI (kg/d)	23.6	22.8	22.0	20.5	<0.01	0.05	NS
NDF Intake (kg/d)	6.9	6.8	8.4	8.2	<0.0001	NS	NS
Ruminal NDF Pool (kg)	6.3	6.7	7.2	7.2	<0.01	NS	NS
NDF Turnover Time (h)	22.0	23.4	20.4	21.1	<0.01	0.06	NS
Kp for INDF (%/h)	3.73	3.13	3.55	3.27	NS	<0.0001	0.09
TCT (min/d)	666	658	764	796	<0.001	NS	NS
TCT / NDFI (min/kg)	103	104	96	103	NS	NS	NS
RT (min/d)	394	395	465	496	<0.001	NS	NS
RT / NDFI (min/kg)	60.7	62.3	58.5	64.5	NS	NS	NS

HFD: High NDF Digestibility, LFD: Low NDF Digestibility NDF: Effect of dietary NDF level, FD: Effect of NDF digestibility, NDF x FD: Interaction of dietary NDF level and NDF digestibility, INDF: Indigestible NDF estimated by 120h-in vitro fermentation Kp: rate of passage, TCT: Total Chewing Time, RT: Rumination Time

Key Words: Brown Midrib, NDF digestibility, Effective Fiber

1396 Physical effectiveness of NDF in alfalfa silages differing in particle size and maturity. E. M. G. Nadeau* and M. S. Allen, *Michigan State University, East Lansing.*

Effects of alfalfa particle size and maturity on physical effectiveness of NDF were evaluated using 8 multiparous Holstein cows (153 DIM) in a duplicated 4 x 4 Latin square design. Alfalfa was cut at early bloom (37.7% NDF, 24.1% CP) and early seed pod (45.2% NDF, 16.5% CP), chopped at 6 or 19 mm theoretical length of cut, and ensiled in bags. In vitro NDF digestibility at 30 h was higher for early cut by 8 units (37% vs. 29%). Diets containing each silage as a sole source of forage were formulated to contain 30% NDF and 18.5% CP. Forage NDF as a percent of total NDF was 88% for early cut and 81% for late cut diets. Interactions of main effects were not detected. Intakes of DM, NDF, and forage NDF increased by long cut. Ruminal NDF pool size and turnover time were not affected by treatments. Long and early cut treatments increased total chewing time (TCT) and ruminating time (RT) per day. When chewing activity was expressed per kg NDF intake, early cut tended to increase TCT and RT, whereas long cut tended to decrease TCT and RT. TCT and RT per kg of forage NDF intake tended to decrease with long cut but were not affected by alfalfa maturity. Early cut alfalfa resulted in greater physical effectiveness of NDF because forage NDF was a greater proportion of total NDF. Higher NDF digestibility of early cut alfalfa did not decrease effectiveness of forage NDF.

Variable	Short cut		Long cut		P value	
	Early	Late	Early	Late	Stage	PS
DMI (kg/d)	15.6	16.2	18.1	17.9	NS	0.06
NDFI (kg/d)	4.0	4.1	5.0	5.5	NS	<0.01
Forage NDFI (kg/d)	3.5	3.3	4.5	4.5	NS	<0.01
Ruminal NDF Pool (kg)	5.5	5.1	6.3	5.2	NS	NS
NDF Turnover Time (h)	29.1	29.1	27.8	27.7	NS	NS
TCT (min/d)	594	506	698	571	<0.01	<0.01
TCT / NDFI (min/kg)	152	137	143	105	0.05	0.09
TCT / Forage NDFI (min/kg)	173	173	161	128	NS	0.07
RT (min/d)	368	305	416	331	<0.01	0.03
RT / NDFI (min/kg)	93	84	85	61	0.07	0.07
RT / Forage NDFI (min/kg)	106	106	96	74	NS	0.06

Stage: Alfalfa Maturity (Early or Late), PS: Particle Size, NDFI: NDF Intake, TCT: Total Chewing Time, RT: Ruminating Time

Key Words: Alfalfa Silage, Physical Effectiveness

1397 Interactions between forage and wet corn gluten feed as fiber sources. D. M. Allen* and R. J. Grant, *University of Nebraska, Lincoln.*

Twelve early lactation Holstein cows (4 fistulated) were used in a 4 x 4 Latin square with 4-wk periods. Objectives of the trial were to determine the effective NDF (eNDF) value of wet corn gluten feed (WCGF) and to measure the effect of additional forage fiber on rumen mat consistency, passage rate of WCGF, rumination activity, and milk production. The four diets were isonitrogenous and consisted of 1) low fiber (LF), formulated to 23.4% NDF (17.4% NDF from alfalfa silage); 2) high fiber (HF), LF diet + 11.1% NDF from alfalfa silage; 3) WCGF without chopped alfalfa hay (-H), LF diet + 10.7% NDF from WCGF; and 4) WCGF with chopped alfalfa hay, 8.6% NDF from alfalfa silage + 8.9% NDF from chopped alfalfa hay + 10.7% NDF from WCGF. The DMI was significantly increased with the addition of WCGF ($p < 0.10$). Efficiency of FCM produced per kilogram DMI was not different among treatments. A significant reduction in milk fat percentage was observed between HF and LF diets (3.25 vs. 2.90; $p < 0.03$). Therefore, the calculated eNDF factor for WCGF was 0.74 compared to 1.0 for alfalfa silage. Rumens mat consistency increased for the +H diet and was significantly different from other treatments ($p < 0.10$). Passage rate of WCGF was reduced significantly with the addition of hay (0.064 vs. 0.042/h; $p < 0.09$). However, in situ digestion kinetics of WCGF were unaffected by treatments. Rumination activity was measured to calculate the physically effective NDF (peNDF) factor for WCGF to be 0.11 compared with 1.0 for alfalfa silage. Minutes spent ruminating were significantly different for HF and +H diets compared with LF and -H diets ($p < 0.10$). WCGF can successfully replace 74% of alfalfa silage in a lactating dairy cow ration. The inclusion of chopped alfalfa hay to a diet containing WCGF maintained rumen mat consistency, rumination activity, and passage rate similar to HF diet.

Key Words: Effective NDF, Forage, Fibrous Coproducts

1398 Effects of starch source and level of FNDF on performance by dairy cows. A. L. Slater*, M. L. Eastridge, J. L. Firkins, and L. J. Bidinger, *The Ohio State University, Columbus, OH.*

Forty-eight Holstein cows were blocked by parity and calving date and randomly assigned within a block to one of four diets: 1) 21 % forage NDF (FNDF) with corn (C), 2) 16 % FNDF with corn, 3) 16 % FNDF with corn and wheat (CW; 1:1), and 4) 11 % FNDF with linted cottonseed (WCS) and corn. The NDF from soyhulls (SH) and WCS replaced a portion of FNDF (40:60 alfalfa silage:corn silage) and concentrate. Fatty acids were 4 % of DM, with supplemental fat provided from tallow and WCS. A covariate diet was fed during wk 8 to 9 of lactation. Diets were fed wk 10 to 25 of lactation as a TMR. Dietary FNDF levels were lower than expected. The DMI and milk yield were highest for cows fed 11 % FNDF with WCS. Milk fat percentage was highest for cows fed 21 and 16 % FNDF with corn. Cows fed 16 % FNDF with corn and wheat had milk fat-protein inversion. The A:P ratio were highest for cows fed 16 % FNDF. One cow fed 21 % FNDF had a RDA. Four cows fed 16 % FNDF with corn had a DA. One cow fed 16 % FNDF with corn and wheat and two cows fed 11 % FNDF with WCS had a LDA. For cows in midlactation, FNDF may be reduced to 9 to 11 % when WCS is fed at 11 % of the DM and dietary starch is reduced to 30 %, and may be reduced to 14 to 16 % without WCS when starch is at 30 % of dietary DM.

Item	Forage NDF				SE
	21 %;C	16 %; C	16 %;C&W	11 %; WCS	
NDF, % of DM	27.5	32.7	33.9	35.6	-
FNDF, % of DM	17.8	14.0	13.9	9.36	-
Starch, % of DM	32.3	29.9	29.9	30.3	-
DMI, kg/d	22.5 ^{bc}	23.0 ^b	21.9 ^c	24.8 ^a	0.3
Milk, kg/d	32.8 ^c	33.4 ^c	34.5 ^b	35.6 ^a	0.3
Milk fat, %	3.52 ^a	3.61 ^a	3.25 ^b	3.35 ^b	0.03
Milk protein, %	3.30 ^{ab}	3.27 ^b	3.31 ^a	3.28 ^b	0.01
Ruminal A:P	2.42 ^{bc}	2.90 ^{ab}	2.94 ^a	2.37 ^c	0.18
Total chewing, min/d	554	547	493	511	28.0

a, b, c: Means in a row with different superscripts differ ($P < .05$).

Key Words: Forage Neutral Detergent Fiber, Starch, Milk Yield

1399 Influence of hull-less oats on feedlot performance and carcass characteristics in beef steers. D. E. Schimek*, M. L. Bauer, J. S. Caton, V. L. Anderson, D. V. Dhyuvetter, and P. T. Berg, *North Dakota State University*.

One hundred and forty-four crossbred beef steers ($282.7 \pm .8$ kg) were used to evaluate hull-less oats (HO; var. *Paul*) when substituted for corn in finishing diets. Five diets were fed using the following ratios of corn to HO: 0:100, 25:75, 50:50, 75:25, and 100:0. The diet contained 5% alfalfa hay, 5% corn silage, 84.8% dry-rolled corn or HO, and 5.2% supplement. Diets were formulated to contain .7% Ca, .7% K, .32% P, 27.5 g/t monensin, and 11 g/t tylosin. Steers were blocked by weight and randomly allotted to one of five treatments (5 pens/treatment except 100% corn; 4 pen/treatment). Initial weights were an average of two-consecutive days following a 3-d restricted feeding period (1.75% of BW) of 50% alfalfa hay and 50% corn silage (DM basis). Steers were weighed every 28 d. Final weights were based on hot carcass weights at a 62% dress. Steers were slaughtered in a federally inspected facility on d 182 and 202. Carcass characteristics measured included hot carcass weight, liver score, ribeye area, fat thickness, marbling, and yield grade. On d 84, dry-rolling of HO was discontinued for the 100% HO treatment; therefore, statistical analysis after d 84 did not include the 100% HO treatment. Performance data through d 84 showed a linear, quadratic, and cubic response in ADG (kg/d; 1.50, 1.43, 1.35, 1.36, 1.02; $P < .05$), a linear decrease in DMI (kg/d; 8.4, 8.0, 7.1, 7.0, 5.8; $P < .001$), and feed efficiency was unaffected (mean = .186; $P = .28$) with increasing levels of HO. Performance data from beginning to the end of the trial for treatments with 0, 25, 50, and 75% HO showed linear decreases in DMI (kg/d; 9.2, 8.9, 8.3, 8.0; $P < .001$) and ADG (kg/d; 1.49, 1.42, 1.35, 1.30; $P = .05$) as HO increased. There was no effect on feed efficiency (mean = .163; $P = .98$). Hot carcass weight, ribeye area, marbling, and fat thickness decreased with increasing HO ($P < .10$). Liver score and yield grade ($P > .60$) were not affected by treatment. These data suggest that including dry-rolled HO in finishing diets reduces DMI and ADG of feedlot cattle.

Key Words: Hull-less Oats, Feedlot, Cattle

1400 Stimulation of the brain's frontal lobe elicited body movements and parotid secretion in sheep. W. L. Grovum*¹ and J. S. Gonzalez², ¹*University of Guelph, Ontario, Canada*, ²*University of Leon, Spain*.

Parotid saliva contains buffers but ruminal acidosis still develops in high producing beef and dairy cattle. To address this problem, some feed buffers, while others increase parotid secretion with better management of diets or feeding. A long term alternative is to increase secretion rates by finding safe drugs to selectively stimulate neurons in the parotid centers in the brain. To expedite such work, the authors located parotid centers in the brainstem (Proc. Soc. Nutr. Physiol. 3:76, 1994) and now report similar centers in the forebrain. The acute experimentation was done with 13 Suffolk crossbred ewes (50–74kg) anesthetized with 15mg sodium pentobarbital/kg I.V. plus a maintenance infusion. In each sheep, the right parotid and submaxillary ducts were cannulated via the mouth and saliva was measured with infrared drop counters connected to a polygraph. The head was mounted in a stereotaxic device to remove the skull and dura and to expose the cerebrum on both sides of the sagittal sinus. The right cortex was then stimulated (8–20v, 40Hz, 1ms) by drawing a bipolar electrode over its surface. There were no effects of stimulating the olfactory bulbs but stimulating the frontal cortex 2–8mm off of midline from the front of the brain backward for 30mm caused movements in order of the lower jaw, face in general, neck, shoulder and front and back legs. Parotid secretion was elicited on the right in 10 sheep by stimulating the prefrontal cortex 15–20mm from midline and under the apex from 0–15mm (not caused by associated chewing, swallowing and respiratory inhibition). Grants from NSERC (OGP0002377) and NATO (fellowship for J.S.G.) and technical help from W.W. Bignell are acknowledged.

Key Words: Saliva, Brain, Sheep

1401 Abomasal infusion of saliva increases reticulo-ruminal motility, passage and intake of cattle. M. A. Froetschel*, C. D. Allred, H. E. Amos, and A. H. Parks, *The University of Georgia, Athens*.

Regulatory peptides exist in saliva that may effect gastrointestinal motility. An experiment was conducted to determine if abomasal infusion of saliva during feeding would influence intake, reticulo-ruminal motility and digesta passage of cattle. Approximately 8 L of saliva was collected daily from two esophageal steers prior to feeding. Saliva (approximately 200 L) was stored frozen, thawed, composited and refrozen prior to infusion. Four ruminal and abomasal cannulated steers (787 kg BW) were infused daily, during feeding, with increasing concentrations of saliva in McDougalls buffer (bovine saliva mineral replacement) in a Latin square design. Steers were given 4h access to a 60:40 blend of corn silage and concentrate fed at 110% of the previous d intake. During feeding, steers were abomasally infused with 0:1000, 250:750, 500:500 and 1000:0 ml saliva:buffer/h. Experimental periods were 7 d in duration. Intake (DM/BW) increased, in a quadratic manner ($P < .05$), from 3.5 to 5.1% with the 250/750 and 500/500 infusates. Intake of steers infused with 0:1000 and 1000:0 infusates consumed 1.23% of BW as DM. The intake response was observed 2 h into the meal. Ruminal contents, before feeding, were not influenced by treatment. After feeding ruminal DM and liquid contents increased quadratically ($P < .05$) similar to intake but liquid contents decreased 6.4% with the 1000:0 compared to the 0:1000 infusate. Ruminal dilution rate (L/h) was quadratically related to treatment ($P < .1$) and decreased 4.2 % with 500:500 and increased 5.4 % with the 1000:0 compared to the 0:1000 and 250:750 infusates (7.2 %/h). Reticular contraction frequency increased linearly ($P < .05$) from 1.4 to 5.7% during infusion. The organic fraction of saliva stimulates reticulo-ruminal motility, digesta passage and intake of cattle.

Key Words: Reticulo-ruminal Motility, Intake, Saliva

1402 The efficiency of ruminal microbial protein synthesis in sheep fed forages of differing nutritional quality. M. A. Karlsli*, J. R. Russell, and M. A. Cerrillo, *Iowa State University, Ames*.

Six wethers, fitted with ruminal and duodenal cannulae, were utilized in a 2 x 3 metabolism trial to determine efficiency of microbial protein synthesis in the rumen of sheep fed forages with varying quality. Ground alfalfa hay, oat-berseem clover hay and baled corn crop residues were fed at an ad libitum or limited intake level. Intake levels of sheep fed alfalfa and oat-berseem clover hay were equal to the ad libitum intake level of corn crop residues while that of corn crop residues was 75% of the ad libitum intake of corn crop residues. Chromium-mordanted fiber was used to determine digesta flow and solid passage rate. Cobalt-EDTA was used to calculate dilution rate and purines were used to estimate microbial protein production. Dry matter intake (g/d, $P < .05$), ruminal OM digestibility (%; $P < .05$), OM apparently ruminally digested (g/d; $P < .05$) and OM truly ruminally digested (g/d; $P < .05$) were 1294, 49.6, 588, 834; 516, 46.4, 203, 301; 962, 44.5, 378, 561; 602, 45.6, 242, 332; 478, 41.7, 265, 289; and 450, 42.4, 200, 260 in sheep ad lib and limit-fed alfalfa, oat-berseem clover and corn crop residues. Rate of solid passage and post-feeding ruminal ammonia-N concentrations were lower ($P < .05$) in sheep fed corn crop residues than those fed the legume hays. Total duodenal flows (g/d; $P < .05$) and efficiencies of ruminal synthesis (g/OM truly digested; $P < .05$) of microbial protein were 21.3, 20.7; 10.4, 22.9; 17.9, 22.8; 10.9, 20.4; 5.5, 17.4; and 5.8, 17.3 in sheep ad lib and limit-fed alfalfa, oat-berseem clover and corn crop residues. While total duodenal microbial-N flow was related to OMI ($r^2 = .97$), OM truly digested in the rumen ($r^2 = .95$) and N intake ($r^2 = .91$), microbial efficiency was related to solid passage rate ($r^2 = .68$).

Key Words: Forage, Microbial Efficiency, Sheep

1403 Aerobic stability, dry matter recovery and ruminal digestion of high moisture ear corn preserved with microbial inoculate. J. E. Nocek¹, G. D. Young¹, and J. G. Allman*², ¹ Spruce Haven Farm and Res Ctr, Union Springs, NY ²Chr. Hansen's Biosystems, Milwaukee, WI.

High-moisture ear corn (HMEC) was harvested (65% DM), treated with microbial inoculants and ensiled in Ag-Bags (8-12 ton batches) for subsequent evaluation of aerobic stability, dry-matter recovery (DMR) and ruminal digestion. Treatments were as follows: a) control: no inoculant, b) *Lactobacillus plantarum* 401/*Pediococcus pentosaceus* 202 (Lp401/Pp202, water soluble), c) *Bacillus subtilis* 9 (Bt-S9, water soluble), and d) *Lactobacillus plantarum* 1/*Pediococcus cerevisiae* 3 (Lp1/Pc3, dry application). Application rate was 100,000 cfu/gm DM. DMR was evaluated by filling nylon sacks with 3 to 5 kg of HMEC and incorporating them into Ag-Bags at filling with subsequent recovery and weighing at feed out (about 45 d post ensiling). Aerobic stability was determined by filling 11 two-liter containers of HMEC and placing them in a thermo-insulated container with moistened sponges on the bottom. The system was maintained at approximately 16°C. Temperature was measured daily on all containers, and pH on one, which was destroyed. An initial sample of HMEC was obtained at feedout for evaluation of in situ DM and starch digestion. Time to raise temperature of HMEC 2°C post-aerobic exposure was 7.8, 5.9, 10.3 and 12.0 d for control, Lp401/Pp202, Bt-S9 and Lp1/Pc3 respectively. There was no effect of inoculant on mean pH with time. There was no effect of inoculant on DMR. A tendency was present for inoculation to increase ($P < .10$) the proportion of starch in the A-fraction relative to the B-fraction. No difference ($P > .10$) in the rate of B-fraction starch digestion was detected, however, rates for inoculated HMEC were numerically higher than control (3.5 vs 5.8, 4.2 and 5.1%/h for control, Lp401/Pp202, Bt-S9 and Lp1/Pc3, respectively). The results of this study show inoculation of HMEC with Bt-S9 and Lp1/Pc3 increased aerobic stability 2.5 to 4.2 d. All inoculants tended to increase the proportion of water soluble starch.

Key Words: Inoculant, Corn, Digestion

1404 Effects of fibrolytic enzyme additives on extent of digestion and milk production of lactating cows. K. A. Beauchemin^{1*}, W. Z. Yang¹, and L. M. Rode¹, *Agriculture and Agri-Food Canada, Lethbridge.*

Effects of using alfalfa cubes containing fibrolytic enzymes in dairy cow diets were evaluated in a 4 × 4 Latin square design using four cannulated lactating cows. Diets consisted of 45% concentrate, 45% alfalfa cubes, and 10% barley silage (DM basis). The diets were: a) control cubes; b) cubes treated with 1g of enzyme mixture/kg hay (LH); c) cubes treated with 2 g of enzyme mixture/kg hay (HH); and d) concentrate and cubes both treated with 1g of enzyme mixture/kg total DM (HT). The enzyme mixture Pro-Mote[®] was provided by Biovance Technol. Inc. (Omaha, NE). Cows were offered a TMR three times daily for ad libitum intake. Dry matter intake was not affected by added enzymes (LH, HH, HT vs control; 20.7 vs 20.4 kg/d). Total tract digestibility was higher ($P < .05$) for cows fed HH or HT diets than for cows fed the control diet (HH, HT vs control; OM, 66.8 vs 64.4%; NDF, 43.0 vs 38.8%). Digestibility of OM and NDF in the total tract for the LH diet was intermediate. Ruminal digestibility of OM and NDF was numerically higher for cows fed diets containing the higher level of enzyme supplementation (HH, HT vs. control; OM, 57.8 vs. 54.1%; NDF, 36.3 vs. 30.7). Ruminal microbial N synthesis was 41 g greater and ruminal protein degradability was 10 percentage units higher for cows fed HH or HT diets than for cows fed the control diet, with no difference between control and LH diets. As a result, cows fed diets with supplemental enzymes produced 4% (LH, 24.6 kg/d, $P < .03$) or 7% (HH, HT, 25.5 kg/d, $P < .05$) more milk than cows fed the control diet (23.7 kg/d). Milk protein (HH, HT vs. control; 3.49 vs 3.36%) and lactose (HH, HT vs. control; 4.61 vs 4.56%) contents were also higher ($P < .01$) for cows fed HH or HT diets than for cows fed the control diet. Adding a fibrolytic enzyme mixture to forage or concentrate enhanced feed digestibility and milk production. The response to enzyme treatment of feed was affected more by enzyme level than by whether the enzyme was added to forage or concentrate.

Key Words: Feed Enzymes, Digestibility

1405 The nutritive value of *Dialium guineense* and its ruminal ammonia and volatile fatty acid concentrations. I. I. Osakwe*, H. Steingass, W. Drochner, and R. Mosenthin, *University of Hohenheim, Germany.*

There is a scarcity of information on the available germplasm in Sub-Saharan Africa, in spite of a considerable diversity in forage trees. Researchers have tended to overlook many other valuable trees including *Dialium guineense*. The objective of this study was to investigate the effects of *Dialium guineense* supplementation to a basal hay diet on ruminal ammonia and volatile fatty acid concentrations. Nine West African Dwarf sheep, all castrates and about two years of age were used in this study. Six of the sheep were fistulated and used for ruminal ammonia and volatile fatty acid (VFA) determination in a randomized complete block design with three treatments in two blocks and repeated on three consecutive days. Data were analysed using Repeated Measurement Analysis. Dried leaves of *Dialium guineense* were offered at two levels (25% and 50% of DM requirement) as supplements to a basal hay diet. Rumen liquor was sampled one hour before and one, three and five hours after feeding. Sheep fed the control diet had a higher ($p < 0.05$) ammonia concentration in the rumen than those fed the diet supplemented with 25% *Dialium guineense* (D25%). Similarly, the ammonia concentration in the rumen was higher ($p < 0.05$) in sheep fed the control diet than those fed the diet supplemented with 50% *Dialium guineense* (D50%). However, the difference between sheep fed D25% or D50% was not significant ($p > 0.05$). The differences between the sampling periods were high ($p < 0.05$). The VFA concentrations of sheep fed the control diet was superior ($p < 0.05$) to those fed the D25% and D50% diets. However, there was a difference ($p < 0.05$) between the VFA concentrations of sheep fed D25% and D50% diets. It was concluded that *Dialium guineense*, in spite of its high crude protein content (143g/kg) showed a poor potential as a supplementary fodder probably due to its high condensed tannin content (59g/kg)DM. *Dialium guineense* could hardly meet the FAO (1986) recommendation of ammonia concentration in the rumen required for efficient rumen function.

Key Words: *Dialium guineense*, Sheep, Ruminal Ammonia

1406 Phosphorus balance of dairy cows in early lactation at three levels of dietary phosphorus. Z. Wu*, L. D. Satter, R. Sojo, and A. Blohowiak, *US Dairy Forage Research Center, USDA-ARS, and Dairy Science Department, University of Wisconsin, Madison.*

Phosphorus balances during the first 8 wk of lactation were determined. Twenty-six multiparous Holsteins were assigned at parturition to treatments with .32, .42, or .52% dietary P (DM basis), obtained by addition of NaH₂PO₄ to the .32% P diet. Blood samples were taken on d 5 post-partum. Milk and fecal samples, along with additional blood samples, were taken every other wk during the first 8 wk of lactation. The bi-weekly fecal samples were composites from 8 consecutive am and pm samples. Percentages of P apparently digested were determined using Yb as a marker. Over the 8 wk, no differences in DMI, milk yield, blood serum P concentration, or apparent digestibilities of DM or P were found. Fecal P excretion increased as dietary P was increased. Ignoring urinary P (usually negligible), P balance was calculated (P intake – fecal P – milk P) and was negative for the .32% P group but positive for the .42% and .52% P groups. Dietary P at .42% was sufficient to support a positive P balance, and feeding a higher amount of P for early lactation (.48% NRC, 1989) appeared unnecessary.

Item	.32% P (n=8)	.42% P (n=9)	.52% P (n=9)	SEM	P
DMI, kg/d	21.4	20.1	20.4	.6	.33
Milk, kg/d	38.9	39.7	37.4	2.5	.81
Serum P, mg/dl	5.8	5.9	6.0	.4	.90
DM digestibility, %	62.0	65.8	64.0	2.6	.50
P digestibility, %	37.3	42.7	42.7	4.0	.57
P balance, g/d					
Intake	70.5	86.7	108.4	2.5	.01
Feces	44.6	49.9	61.5	4.2	.03
Milk	32.2	33.9	31.2	1.9	.60
Balance	-5.6	2.7	15.3	4.1	.01

Key Words: Dairy Cows, Phosphorus Requirement, Phosphorus Balance

1407 Site of mineral absorption in Holstein heifers fed whole crop cereal grain silage or alfalfa silage. A. Suleiman^{1*}, G. R. Khorasani², E. Okine¹, L. A. Goonewardene¹, and J. J. Kennelly², ¹Alberta Agriculture, Edmonton, Canada, ²University of Alberta, Edmonton, Canada.

Objectives of this study were to determine the site and extent of absorption of Ca, P, and Mg in four Holstein heifers (546 ± 7.07 kg) cannulated in the rumen, duodenum and ileum. Barley silage (Duke, AC-Lacombe, and Sebee varieties) were harvested at the soft dough stage and alfalfa was harvested as second cut, in mid-bloom. At harvest, forage DM was 22.3, 27.4, 30.0 and 29.6% for Duke, AC-Lacombe, Sebee and alfalfa, respectively. The Ca, P, and Mg contents of Duke, AC-Lacombe, Sebee, and alfalfa silage were 0.68, 0.39, 0.24; 0.66, 0.38, 0.24; 0.46, 0.33, 0.19; and 2.04, 0.41, 0.39% on a DM basis, respectively. Diets contained 20% concentrate and 80% of each of the test silage. The design was a 4 × 4 Latin square and each experimental period was 3 weeks in length. The concentrate contained 1.45% Ca, 0.42% P, and 0.18% Mg. Dry matter intake was higher for animals fed alfalfa silage (8.68 kg/d) compared to those fed AC-Lacombe silage (6.74 kg/d), but did not differ among other dietary treatments. Apparent total tract digestibility of Ca was higher for cows fed AC-Lacombe compared to that of cows fed Duke (42.4 vs. 35.0%, $P < 0.05$), whereas apparent digestibility of Mg (38.2% ± 5.03) was not different among treatments. Apparent digestibility of P was highest for cows fed AC-Lacombe, intermediate for cows fed Duke and Sebee, and lowest for cows fed alfalfa. The major site of P absorption was post-ruminal, whereas, the rumen and the intestine were the major sites of Ca and Mg absorption. The site of absorption was not affected by forage source, but the extent of Ca, P, and Mg absorption was significantly influenced by forage source.

Key Words: Cereal Silage, Alfalfa, Minerals

1408 The association of high potassium forages with metabolic diseases in Holstein cows. R. L. Crill*, D. J. Carroll, M. R. Keller, and S. T. Morris, Oregon State University, Corvallis.

Potassium concentrations have been increasing on manure fertilized soils adjacent to dairy operations. Grasses grown on these fields mirror the increase in available soil K. When high K forages are fed to dry cows, it has been associated with increased hypocalcemia parturient paresis (milk fever). The objective of this field trial was to identify the factors that differ between low and high occurrence of metabolic diseases when high K forages were fed. For 1 yr, a monthly on-site interview was conducted on 10 dairies in Western Oregon. Records collected included: rations offered throughout the periparturient phase, dry date, calving date, dystocia, twinning rate, crowding (area/cow), cow comfort, group DMI, health, and lactation number. Cows were diagnosed in the early postpartum period as either healthy or as having one or more of the following metabolic diseases: milk fever, retained fetal membranes, and left displacement of the abomasum. Feedstuffs were collected each month and analyzed for DM, CP, ADF, macro and microminerals. Soil samples from grass fields were collected at the start and end of the trial. Soil results were analyzed using a paired means two-sample t-test. The average decrease in soil K was 304 mg/kg. This is evidence that one growing season can mine a significant amount of K from the soil ($P < 0.05$). Of the cows (n=3884) examined, twins were observed in 5.5%. Incidences of milk fever, retained fetal membranes, left displacement of the abomasum were 3.3, 11.9, and 1.4%, respectively. The K concentration in close-up rations for herds that experienced milk fever was 1.8% compared to 1.6% for herds that did not experience milk fever. The relationship between dietary potassium concentrations and the occurrence of milk fever on dairy operations is multi-faceted.

Key Words: Potassium, Milk Fever

1409 Comparison of magnesium sources in diets of finishing lambs. H. B. Watson*, K. P. Coffey, E. B. Kegley, J. K. Apple, and W. R. Ratchford, University of Arkansas, Fayetteville.

Magnesium-mica (MM) is a mined mineral supplement having magnesium (Mg) availability similar to that of magnesium oxide (MgO). Magnesium-mica also has high levels of iron, raising concerns about its long-term use. The objective of this study was to compare effects of supplemental magnesium sources in lamb finishing diets on animal weight gain and diet digestibility. Twenty Rambouillet wether lambs (36.2 kg) were housed randomly in individual pens (1.49 X 1.07m) having expanded metal floors for a 95-d finishing study. Lambs were allocated randomly to one of four ground corn-based finishing diets. Dietary treatments consisted of a control (no supplemental Mg source), MgO at 0.16% of the diet, unweathered MM (UMM) at 0.9% of the diet, or weathered MM (WMM) at 1% of the diet. Magnesium sources were added to provide .9 g Mg/kg diet. The proportion of cottonseed hulls in the diets was replaced by ground corn from 55% initially to 15% in the final ration over a 4-wk period. Four lambs from each dietary treatment were selected randomly to measure diet digestibility. Lambs were fitted with fecal collection bags and allowed a 2-d adjustment period followed by five d of fecal collection at 0730 and 1600 h daily. Total weight gain, DM intake, gain:feed and wool production did not differ ($P < .10$) among diets. Likewise, hot carcass weight and dressing percentage did not differ ($P < .10$) among diets. Lambs fed MgO and UMM had greater DM ($P < .05$) and OM ($P < .10$) digestibilities (%) than those fed WMM, but digestible DM and OM intake (g/d) did not differ ($P < .10$) among diets. Dry matter and OM digestibilities (%) by lambs fed the control diet did not differ ($P < .10$) from those fed the other diets. Although no apparent benefits were observed on parameters measured in this study, other benefits of MM inclusion, such as feed flow and pellet binding qualities, might be considered. As no adverse effects were noted from any of the diets, we conclude that high iron levels from MM do not pose a problem when included up to 1% in finishing diets of lambs fed for extended periods.

Key Words: Magnesium-mica, Lamb, Digestibility

1410 Effects of high zinc levels on urea utilization by cattle fed prairie hay. H. M. Arelovich*, F. N. Owens, G. W. Horn, and J. A. Vizcarra, Oklahoma State University, Stillwater.

Six 363 kg ruminally cannulated heifers were fed prairie hay (PHAY) and one of two levels of urea in two simultaneous 3 × 3 Latin squares with one square at each urea level (9.5 and 19 g urea/kg DM); Zn levels were assigned within each square. The basal diet, a medium quality PHAY, was fed at fixed level of 4.8 kg of DM split in two daily meals. Zinc chloride provided the equivalent of either 30 ppm (ZN1- the dietary requirement), 250 ppm (ZN2) or 470 ppm (ZN3) of Zn. Additionally, 40 ppm of Mn from MnCl₂ was provided. The urea-mineral supplements were dosed via cannula once daily. After 7 days of adaptation, the rumen was sampled 2, 4, 6, 12, 18, 21 and 24 hr after feeding the supplement on day 8; ad lib intake of PHAY was measured on days 9–16. Ruminant pH and NH₃ response to urea and Zn levels differed with time, with Zn × time interactions for both pH ($P = .049$) and NH₃ ($P = .066$). In general, pH was lower from 12–24 hr than during 2–6 hr (6.68 vs 6.98; $P = .0001$). Concentrations of NH₃, highest for all treatments at 2 hr (56, 43 and 35 mg/dL for ZN1, ZN2 and ZN3), decreased ($P = .0001$) with added Zn. This may reduce toxicity. Rumen NH₃ concentrations decreased over time, being higher from 2–6 hr than 12–24 hr ($P = .0001$). The Zn × time interaction was best described by a cubic regression on time ($P = .1014$, $R^2 = .9777$). Using dummy variables, NH₃ concentrations over time differed between ZN1 vs ZN3 ($P = .039$). Ammonia concentrations fell below 5 mg/dL sooner with ZN1 than ZN2 (8.9 vs 13.4 hr postfeeding). Neither urea nor Zn significantly affected intake or digestibility, but digestible DM intake tended to be reduced at the highest Zn level (ZN1=29.2, ZN2=26.2 and ZN3=23.4 g/kg W^{.75} respectively). Prolonging the time period with adequate NH₃ concentrations should favor Zn supplementation.

Key Words: Urea, Zinc, Cattle

1411 Effects of zinc levels on performance, carcass characteristics, and serum concentrations of cholesterol and fatty acids of finishing beef steers. K. J. Malcolm-Callis* and G. C. Duff, *Clayton Livestock Research Center, New Mexico State University, Clayton.*

One hundred eight medium-framed (British x Continental) beef steers were used to determine the effect of zinc levels on performance and carcass characteristics. Steers were randomly assigned to 12 pens, resulting in four pens of 9 steers per treatment diet. Treatment levels of added zinc sulfate were 1) 20 mg/kg, 2) 100 mg/kg, or 3) 200 mg/kg. Treatment diets were 90% concentrate with steam-flaked corn as the grain source. No differences ($P > .10$) were noted between treatments for daily gain. However, cattle fed 20 mg/kg of added zinc had numerically greater daily gain than cattle fed 100 mg/kg or 200 mg/kg. There was a linear ($P < .10$) decrease in daily DMI with increasing zinc concentrations suggesting that higher concentrations of zinc sulfate may have a negative influence on palatability. No differences were noted ($P > .10$) among treatments in feed:gain ratio. No differences ($P > .10$) were noted in hot carcass weight, dressing percentage, longissimus muscle area, percent kidney, pelvic, and heart fat, or marbling score. There were, however, quadratic effects of added zinc on fat thickness ($P < .05$) and yield grade ($P < .01$). Twelve beef steers were used in a companion study to determine effects of zinc levels on serum cholesterol and fatty acid profiles. Steers were bled once daily on d 0, 28, 56, and 84 to measure serum cholesterol and fatty acids. Serum cholesterol concentrations were not altered with added zinc (.26, .25, and .27 mg/mL for 20, 100, and 200 mg/kg, respectively). No differences ($P > .10$) were observed in percent saturated, monounsaturated, or polyunsaturated fatty acids among the three zinc levels. Increasing zinc concentrations did not improve carcass characteristics and had no influence on serum cholesterol and fatty acids.

Key Words: Beef Cattle, Zinc, Performance

1412 Trace mineral supplementation effects on first-calf beef heifer reproduction, milk production and calf performance. C. K. Swenson*¹, R. P. Ansoategui¹, E. J. Swenson¹, J. A. Paterson¹, and A. B. Johnson², ¹Montana State University, Bozeman, ²Zinpro Corporation, Eden Prairie, MN.

Adequate Cu and Zn balance is essential for maintaining reproductive performance and immunocompetence in beef cattle. Objective of this study was to evaluate effects of supplemental trace element form (complexed vs inorganic) fed in the presence of an antagonistic element on first-calf heifer post-partum interval to breeding (PPB), milk production, and calf performance. Experimental supplements were formulated to provide 25 ppm Cu, 72 ppm Zn, 41 ppm Mn, 2 ppm Co, and 5 ppm Mo (antagonist) on a daily DM intake basis. Treatments also included time of supplementation initiation, 60 d vs 30 d precalving. Angus heifers (n=118) were allotted to the following treatments which were individually fed on alternate days: 1) complexed at 60 d (CX60), 2) complexed at 30 d (CX30), 3) inorganic at 60 d (IN60), 4) inorganic at 30d (IN30), and Mo only (CON). Sodium molybdate was fed in free-choice salt to provide 8 ppm Mo on a daily basis for 30 d presupplementation. Heifers consumed grass hay ad libitum until grass was available for grazing. Data was analyzed using general linear models of SAS with treatment as the main effect; with the exception of Chi Square analysis used for scour treatment values. Values for PPB and scour treatment were pooled by mineral supplement form. Milk production was higher ($P < .10$) for CX60 (8.9 kg/d) compared to CON (6.8 kg/d) and other treatments were intermediate. However, adjusted 205 d weaning weights were similar ($P > .05$) among groups (202 to 217 kg). The PPB was determined utilizing KMar. heat detection patches placed on the heifers at the start of the breeding season. Heifers consuming complexed mineral had exhibited estrus earlier ($P = .05$) in the breeding season, 98d compared to inorganic mineral 106d and CON 108d post-partum. Incidence of scours requiring treatment in calves was 17, 16, and 26% for complexed, inorganic and CON groups, respectively, but were not different ($P > .10$).

Key Words: Heifer, Copper, Zinc

1413 Pre-calving copper supplementation on maternal transfer of copper to the calf and passive transfer of immunity. E. L. Muehlenbein*², G. H. Deutscher², D. R. Brink¹, and M. P. Carlson¹, ¹University of Nebraska, Lincoln, ²West Central Research and Extension Center, North Platte, NE.

Copper supplementation to the cow prior to calving may improve neonatal calf health by increasing the amount of copper transferred to the calf. Seventy-seven first-calf, MARC II heifers were randomly allotted to three treatments: (1) a copper depletion supplement (600mg Fe, 5mg Mo), (2) an inorganic supplement (600mg Fe, 5mg Mo, and 200mg CuSO₄), and (3) an organic supplement (600mg Fe, 5mg Mo, 100mg Availa-Cu, Zinpro[®]). Cows were individually fed the supplements for at least 45 days prior to calving. Liver biopsies were taken to determine the trace mineral status of cows prior to the initiation of the trial and on both cows and calves at 10 days \pm 3 after calving. At calving, a jugular blood sample was taken, and the serum copper level of cows and calves was determined. A colostrum sample was collected prior to the calf nursing and analyzed for IgG and trace mineral content. Cow liver Cu levels were 58 ppm (dry weight basis) before supplementation. At day 10 after calving, cow liver Cu levels in treatment 1 had decreased (23 ppm, $P < .05$) from base levels. Treatment 2 levels increased (88 ppm, $P < .10$) and treatment 3 levels (46 ppm) were not significantly different from base levels. No significant differences were found among treatments in calf liver or in calf serum copper concentrations. Copper supplementation tended to increase the IgG levels of calf serum. Supplementation of Cu from either source did not result in changes in calf Cu status. Based on this information, Cu transfer from cow to calf appears constant and independent of intake at the levels tested.

Key Words: Copper, Organic, Calf

1414 Dietary copper affects performance, liver copper, serum cholesterol, and carcass characteristics of finishing steers. T. E. Engle*, J. W. Spears, C. L. Wright, and T. A. Armstrong, *North Carolina State University, Raleigh.*

An experiment was conducted to determine the effects of dietary copper (Cu) source and level on performance, liver and plasma Cu, serum cholesterol, and carcass characteristics in steers. Fifty-nine Angus (n=36) and Angus x Hereford (n=23) steers were stratified by weight and initial liver Cu concentration within a breed, and randomly assigned to treatments. Treatments consisted of: 1) control (no supplemental Cu); 2) 20 mg of Cu/kg DM from Cu sulfate (CuSO₄); 3) 40 mg of Cu/kg DM from CuSO₄; 4) 20 mg of Cu/kg DM from Cu citrate; 5) 20 mg of Cu/kg DM from Cu proteinate; and 6) 20 mg of Cu/kg DM from tribasic Cu chloride. A corn silage-soybean meal based diet was fed for 56 d. Steers were then switched to a high concentrate diet. Equal numbers of steers per treatment were slaughtered after receiving the finishing diets for either 101 or 121 d. Daily gain, feed intake, feed efficiency, plasma Cu and serum cholesterol were not affected by Cu level or source during the growing phase. Liver Cu concentrations were higher ($P < .05$) in steers receiving supplemental Cu at the end of both the growing and finishing phases. Steers supplemented with 40 mg of Cu/kg DM from CuSO₄ had higher ($P < .05$) liver Cu concentrations than those supplemented with 20 mg of Cu/kg DM from CuSO₄. Gain, feed intake and feed efficiency were reduced ($P < .05$) by Cu supplementation during the finishing phase. Hot carcass weight and backfat were lower ($P < .05$) in animals receiving supplemental Cu but marbling scores were similar across treatments. Serum cholesterol was lower ($P < .05$) in steers supplemented with Cu by d 84 of the finishing period. These results indicate that as little as 20 mg/kg of supplemental Cu can reduce performance in steers fed high concentrate diets.

Key Words: Cattle, Copper, Cholesterol

1415 Effects of supplemental thiamin on performance and immune function in stressed stocker calves. S. A. Silzell* and E. B. Kegley, *University of Arkansas, Fayetteville.*

Two trials were conducted to determine the effect of supplemental thiamin in a receiving ration on performance, thiamin status, and immune response. In Exp. 1, 32 crossbred calves (211 ± 3.2 kg initial BW) were weaned, blocked by sex and weight, and randomly assigned to eight pens. Pens were then randomly assigned to treatment. Treatments were control (no supplemental thiamin), or 956 mg/d supplemental thiamin as thiamin mononitrate. Calves were kept in .45 ha mixed grass pastures, and fed 1.82 kg/d of a corn and soybean meal supplement, which served as the carrier of the treatments. There were no differences in ADG from d 0 to 14 ($P > .10$); however, ADG from d 14 to 28 ($P < .02$), and ADG over the entire 28 d study ($P < .08$) were decreased by supplemental thiamin. On d 14, blood thiamin monophosphate ($P < .01$) and thiamin pyrophosphate ($P < .03$) were greater for calves fed supplemental thiamin. In vivo cell-mediated immunity, measured on d 28 by determining the response of calves to an intradermal injection of phytohemagglutinin (PHA), was not affected ($P > .10$) by supplemental thiamin. Calves were vaccinated on d 0 for bovine viral diarrhea (BVD), serum samples were obtained and antibody titers were determined on d 0, 7, 14, and 28. There were no treatment x time interactions ($P > .10$) for antibody response to BVD. In Exp. 2, 88 crossbred heifers were purchased and shipped to the facility. Calves were blocked by weight (205 ± 1.6 kg initial BW), assigned to one of 16 pens, and then pens were assigned to treatments. Treatments were identical to Exp. 1. Calves had ad libitum access to bermudagrass hay in this study. Calves supplemented with thiamin had a higher ($P < .10$) morbidity rate (53%) than unsupplemented calves (37%). Average daily gain was not different ($P > .10$) for the entire 42 d study. Skinfold thickness 4 h after an intradermal injection of PHA was smaller ($P < .05$) in calves supplemented with thiamin versus controls. Supplemental dietary thiamin in the receiving ration did not increase ADG or enhance immune function of stressed stocker calves.

Key Words: Beef Cattle, Thiamin, Vitamin

1416 Field investigations of sulfur-associated polioencephalomalacia (PEM). G. H. Loneragan^{1*}, D. H. Gould², and F. B. Garry¹, *Departments of ¹Clinical Sciences and ²Pathology; Colorado State University (CSU). Funded by the Meat Research Corporation, Australia and CSU Ag. Experiment Station.*

PEM is an important neurologic disease of ruminants. Thiamine deficiency and excess sulfur (S) intake are implicated as causal factors of PEM. Following confirmation of PEM in cattle from 2 ranches, potential causes of the outbreaks were investigated. PEM affected 16 of 150 weaned calves on Ranch A over a 2-week period. Ten randomly selected healthy calves were sampled for ruminal gas cap H₂S levels and blood thiamine content. Ruminal gas was drawn through an H₂S detector tube and blood thiamine measured by a thiamine-dependent *Lactobacilli* bioassay. Samples of hay, mineral supplement and water were analyzed for sulfur content. All clinically unaffected animals had elevated ruminal H₂S, (8770 ± 1182 ppm (mean \pm SE)). Previous investigations indicate that cattle receiving diets with less than 0.2% S had ruminal H₂S levels below 1000 ppm. Blood thiamine levels were 98.7 ± 4.1 nmol/L, and all were within published reference range of 75 to 185 nmol/L. Two calves with normal blood thiamine levels (121 and 99 nmol/L) developed clinical signs of PEM within 12 hours of sampling. All dietary components had elevated levels of S. The majority of the dietary S was contributed by hay (0.69 \pm 0.05% S on a DM basis). Hay could be separated into grass (0.33% S) and Canada thistle (*Cirsium arvense* 1.1% S). Estimated total S intake was 0.9% S. Yearling cattle on ranch B grazed on irrigated turnips (*Brassica rapa*) and Essex rape (*Brassica napus*). Thirty out of 4000 displayed signs of PEM over approximately 6-weeks. Eighteen healthy animals were sampled. Blood thiamine levels were not measured since thiamine supplements were given. Ruminal H₂S levels were elevated (3726 \pm 651 ppm). Sulfur content of turnips and Essex rape were 0.63% and 0.91% S respectively. Demonstration of pathological ruminal H₂S levels provides evidence of excess S intake. Coupled with dietary sulfur analysis, this is a useful diagnostic strategy for investigating ruminant neurologic disease.

Key Words: Polioencephalomalacia, Hydrogen Sulfide, Sulfur

1417 Effects of Vitamin D₃ levels on feed intake by yearling steers. K. Karges*, F. N. Owens, D. Gill, and J. B. Morgan, *Oklahoma State University, Stillwater.*

Supplemental Vitamin D₃ improves tenderness of beef cuts but may depress feed intake. Two trials were conducted to determine how high levels of Vitamin D₃ affect feed intake by yearling steers receiving an 80% concentrate ration. In trial 1, treatments included Vitamin D₃ at, 0, 5, 7.5, 15 and 75 million IU (MIU) per steer daily. Utilizing a completely randomized design, 20 steers (362 kg) were allocated to treatments and individually fed their diet (13% CP; 53 Mcal NEg/cwt) with Vitamin D₃ being top dressed onto the ration which was fed once daily. Dry matter consumed was recorded daily. Significant depressions ($P < .05$) in DMI were first observed after 2 d with 75 MIU, at 4 d with 15 MIU, at 5 d with 7.5 MIU, and at 6 d with 5 MIU added Vitamin D₃. The decrease in feed consumed due to added Vitamin D₃ was significant on d 3 ($P < .05$) and linearly related to Vitamin D₃ level starting on d 2 ($P < .05$). In trial 2, treatments included Vitamin D₃ at 0, 450, 990 and 1,363 IU/g feed which at 11 kg daily intake equals 0, 5, 7.5 and 15 MIU/steer daily. Utilizing a completely randomized design, 20 steers (445 kg) were allocated to treatments. Vitamin D₃ was mixed into a pellet and fed as a percentage of the total ration (13% CP; 53 Mcal NEg/cwt) which was fed once daily for 25 d. Significant depressions ($P < .05$) in DMI were first observed after 12 d with both 10 and 15 MIU and at 20 d with 5 MIU added Vitamin D₃. The depression in DMI first became linear on day 12 ($P < .05$). To avoid feed intake depression when Vitamin D₃ is fed at high levels, Vitamin D₃ should be fed as a percentage of the total ration and incorporated into a pellet.

Key Words: Vitamin D3, Steer, DMI

1418 Vitamin E source effects on heifer performance and color stability of steaks. G. M. Hill^{1*}, S. E. Williams², R. L. Stuart³, R. S. Watson¹, M. J. Mathis¹, and T. A. Maddox², *Univ. of Georgia Animal & Dairy Sci. Dept., ¹Tifton, ²Athens, and ³Stuart Products, Inc., Bedford, TX.*

Feedlot heifers (n=54; initial BW 360 \pm 11.3 kg) were fed a basal 85% concentrate diet ad libitum for 110 d. Treatments were no added vitamin E (Control, C), or vitamin E (500 IU/heifer daily) from either synthetic dl- α -tocopheryl acetate (EA; BASF Corp., Mt. Olive, NJ), or from natural source d- α -tocopheryl acetate (EN; Stuart Products, Inc., Bedford, TX), with EA and EN top-dressed daily on the basal diet. British-based heifers were randomly assigned to treatments (3 pens of 6/treatment), and implanted with Synovex-H[®] on d 1. Heifer 28-d ADG, 110-d ADG, 28-d DMI, 110-d DMI (kg), 28-d DM/gain and 110-d DM/gain, respectively, were: C = 1.57, 1.37, 7.2, 8.3, 4.8, 6.0; EA = 1.46, 1.25, 7.9, 8.5, 5.6, 6.8; EN = 1.12, 1.29, 7.8, 8.0, 7.8, 6.2. The 28-d ADG was lower ($P < .05$) for EN than C and EA, and 110-d DM/gain was lower ($P < .05$) for C and EN than EA. After slaughter, loin sections (12 randomly chosen/treatment) were vacuum packaged and stored at 3.3°C. On d 7 post-slaughter, 2.54 cm steaks were cellophane packaged, then observed visually and mechanically scanned for metmyoglobin on d 0, 2, 4, 6, 8, and 10. Visual color scores (4 = slightly dark red, 2 = dark red) and steak surface discoloration (10 = none, 5 = 50%, 1 = 90%), on d 0, 8 and 10, respectively, were: C = 4.8 and 10, 4.3 and 4.3, 2.8 and 1.1; EA = 4.4 and 10, 4.0 and 6, 3.3 and 1.7; EN = 4.5 and 10, 5.0 and 5.3, 3.4 and 1.9; both color and discoloration were similar for treatments until d 8. Metmyoglobin formation reflectance predicted means (%) on d 0, 2, 4, 6, 8 and 10, respectively, were: C = 10.2, 5.5, 8.3, 18.7, 36.7, 62.2; EA = 11.2, 5.3, 6.8, 15.6, 31.8, 55.3; EN = 10.3, 4.8, 6.6, 15.8, 32.5, 56.5; there was a quadratic effect for day ($P < .01$) and no interaction with treatment. Vitamin E source affected heifer performance, and both EA and EN tended to increase color stability of steaks.

Key Words: Heifer, Tocopherol, Vitamin

1419 Effect of ruminally protected choline on the growth performance of Alpine doelings. R. Puchala*, T. Shenkoru, J. Luo, and T. Sahlu, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

The effect of dietary supplementation with ruminally protected choline (RPC) on the growth performance of Alpine doelings was investigated. Thirty-six Alpine doelings (17 wk, 17 ± 1.2 kg BW) were adapted to a completely mixed diet (18% CP, 74% TDN) and allocated to one of three groups on a BW basis. During the experimental period (90 d) the basal diet was supplemented with RPC at 0, 8, and 16 g/kg of DM. Animals received ad libitum access to feed offered twice daily at 1000 and 1500. Average feed consumption (1.15 kg/d) was similar among groups. Average daily gain tended to increase as a result of supplementation at 162, 166, and 172 g/d for 0, 8, and 16 g of RPC, respectively (linear effect, $P = .10$). Feed efficiency was also improved in RPC groups (7.24, 7.04, and 6.84 for 0, 8, and 16 g of RPC, respectively; linear effect, $P < .05$). Supplementation increased plasma choline concentration (2.96, 4.05, and 4.94 μM for 0, 8, and 16 g of RPC, respectively; linear effect, $P < .05$). In conclusion, the observed improvements in average daily gain and feed efficiency with dietary choline inclusion suggest that choline may be limiting in diets for growing Alpine doelings.

Key Words: Alpine Doelings, Ruminally Protected Choline, Growth