there was a significant N x S interaction ($P < 0.036$) following the same pattern above for 4-methylphenol, and a tendency for this interaction to affect phenylacetic acid ($P < 0.092$). During the third collection period, phenol concentration was significantly altered by N ($P < 0.013$) and a N x S interaction ($P < 0.029$), with phenol increasing with reduced S content in the presence of elevated N, and decreasing with reduced S content in lower N diets. 3-methylindole tended to be affected by N ($P < 0.079$), while propanoic acid tended to be affected by S ($P < 0.092$). Reduction of N and S in swine finishing diets does not affect growth performance but can alter the concentration of components implicated in the odorous qualities of swine waste.

Key Words: Waste, Odor, Swine

1589 Effects of dietary supplementation of diatomaceous earth and zeolite on fecal excretion of major odor-causing compounds from growing-finishing pigs fed corn and soybean meal-based diets. Y. Gao, T. C. Rideout*, D. Lackeyram, M. Z. Fan, G. Duns, E. J. Squires, and T. K. Smith, *University of Guelph*.

A trial was conducted to examine the effects of dietary supplementation of natural binding compounds, i.e., diatomaceous earth and zeolite, on fecal excretion of major odor-causing compounds in growing-finishing pigs. Six Yorkshire barrows, with an initial BW of 19 kg, were fed six diets according to a 6 x 6 Latin square design. The diets were corn and soybean meal-based, contained the same amount of CP and AA and differed in the source and level of binding compounds. Diet 1 had no binding compounds and served as the control; diets 2, 3 and 4 contained 1.2, 2.4 and 3.6% of diatomaceous earth; diets 5 and 6 contained 0.6 and 1.2% of zeolite. Ammonia and volatile sulfide contents were analyzed by spectrophotometric analysis, and other odor-causing compounds were determined by using a gas chromatography-mass spectrometer. Supplementing diatomaceous earth and zeolite did not affect the fecal excretion of ammonia, short-chain fatty acids, *p*-cresol or indole. However, adding diatomaceous earth at the levels of 2.4 and 3.6% (diets 3 and 4) decreased ($P = 0.07$ and 0.05) the fecal excretion of total volatile sulfides (2.98 and 2.87 vs. 4.52 g H_2S ·kg DMI) in comparison with the control diet. In conclusion, adding suitable levels of diatomaceous earth in swine diets may effectively decrease volatile sulfide-associated odor and pollution to the environment.

Key Words: Diatomaceous earth and zeolite, Odor-causing compounds, Pigs

1590 Efficacy of various microbial urease inhibitors in controlling ammonia and volatile sulfide emission from swine manure slurry. T. C. Rideout* and M. Z. Fan, *University of Guelph, Guelph, Ontario*.

Three experiments were conducted to evaluate the effectiveness of the microbial urease inhibitors phenylphosphorodiamidate, N-(n-butyl)thiophosphoric triamide, and acetohydroxamic acid in reducing ammonia (NH_3) and volatile sulfide (in hydrogen sulfide unit, H_2S) emission from stored swine manure slurry. Liquid manure slurry was collected from the University of Guelph Arkell Swine Research Station and treated with six graded dosages (0.00, 0.40, 0.80, 1.20, 1.60, and 2.00 g/kg DM manure slurry) of the aforementioned urease inhibitors according to a completely randomized block design. Cumulative NH_3 and H_2S emission was measured over a 7-d period in an *in vitro* measurement system. Ammonia-nitrogen, urea-nitrogen, and volatile sulfide contents of the manure slurry were analyzed at the start and the end of the 7-d emission measurement. There were no differences ($P > 0.05$) in NH_3-N, urea-N, and H_2S contents in the manure slurry at the end of the 7-d emission measurements among the six dosages of the urease inhibitors. As urea hydrolysis in the manure slurry was complete at the start of the emission measurement, there were no differences ($P > 0.05$) in NH_3 emission rates in response to the addition of the urease inhibitors. However, the control groups appeared to have a lower rate of H_2S emission in comparison with the urease inhibitor-treated groups. While the results of this study suggest that the effectiveness of microbial urease inhibitors in controlling NH_3 emission from animal waste is strongly dependent on the time of application, more work is needed to clarify the dose-response relationship between urease inhibitors and volatile sulfide emission from swine manure slurry.

Key Words: Microbial urease inhibitors, Swine manure slurry, Ammonia and sulfide emission

Ruminant Nutrition
Ruminal Fermentation

1591 Effects of barley grain particle size on dairy cow performance. G. R. Ghorbani*[1] and A. Moradai[1], [1]*Isfahan University of Technology*.

Six Holstein cows were used in a 3 x 3 replicated Latin square design to investigate the effect of different particle sizes of ground barley grain on lactation performance. Geometric mean diameters of the barley particles were 0.94, 1.93 and 2.9 mm for treatment 1, 2 and 3 respectively. Diets were only different in barley particle size and all cows received diets containing 40 percent corn silage and 60 percent concentrate (DM basis). About 50 percent of the concentrate was ground barley with different particle sizes. The differences among dry matter intake (DMI), milk fat percentage, milk total solid percentage, daily fat yield, dry matter digestibility, urine, and ruminal pH, daily body weight change, and fecal particle size distribution were not significant. Treatment 3 caused a decrease ($P<0.05$) in milk protein percentage, daily milk yield, and fecal pH compared to treatment 1 and 2, but the differences between treatment 1 and 2 were not significant. With increasing barley particle size, fecal dry matter was increased and daily milk protein yield was decreased significantly ($P<0.05$). Differences between treatments 1 and 2 or 2 and 3 for 4 percent FCM, 4 percent FCM/DMI daily, milk lactose yield, daily total solids yield and organic matter digestibility were not significant, but differences between treatments 1 and 3 for 4 percent FCM and 4 percent FCM/DMI were observed. The soluble fraction, the potential degradable fraction, the ruminal degradation rate and the effective degradability of dry matter increased linearly for treatments 1, 2 and 3, respectively. It is concluded that fine grinding of barley which is commonly used on dairy farms improved OM digestibility, milk yield, protein percentage and production and would be recommended for nutrition conditions similar to the present experiment.

Key Words: Barley, particle size, Dairy cow

1592 Determination of energy values and degradability characteristics of triticale varieties. Ulku Gursoy*[1] and Aydan Yilmaz, [1]*Ankara University Agriculture Faculty, Ankara, Turkey*.

The objective of this research was to investigate the rumen degradability characteristics and energy values of triticale varieties used in ruminant nutrition in Turkey. Three Anatolia Merinos rams (3 yr old and 70 kg live weight) fitted with ruminal cannulas were used. Animals were fed the same ration during the trial. To determine rumen degradabilty characteristics, triticale varieties were incubated in nylon bags for 2, 4, 8, 16, 24, and 48 h in the rumen. Degradability characteristics of DM (dry matter) and OM (organic matter) of feed samples were determined using the equations P = a+b (1-e) and Pe = a+bc/ (c+k)e (McDonald 1981). Effective ruminal degradabilities (at an assumed passage rate of 0.05/h)of triticale varieties for DM and OM were : (Presto, Karma 2000, Tatlycak 97, and Tacettinbey) 76.37, 77.77; 67.97, 70.90; 76.87, 79.57; and 74.94, 77.47. Degradability (%) in 48 h were: 91.35, 91.35; 82.66, 84.19; 88.40, 89.82; and 87.36, 88.62 respectively. The enzyme technique (in vitro) was used to estimate energy values. The ME values (kcal/kg DM) of triticale varieties were 3079, 3012, 3065, and 3046, respectively. Differences for DM and OM (based on DM) effective degradabilities for Presto, Tatlycak, and Tacettinbey varieties were not significant ($P>0.05$), but the Karma 2000 variety was lower ($P<0.05$). When the same varieties were compared for ME values, the Presto and Tatlycak varieties did not differ ($P>0.05$), but differences between the other varieties were significant ($P<0.05$). *This research was summarized from the M.S. thesis of Ulku Gursoy, Ankara University Agriculture Faculty,Department of Feeds and Animal Nutrition.

Key Words: Varieties of Triticale, Nylon Bag Technique, Method of Cellulase, Degradability

1593 Metabolism of 1,2-propanediol in lactating cows under washed reticulo-rumen conditions. N.B. Kristensen*, A. Danfaer, B.A. Rojen, B.-M.L. Raun, M.R. Weisbjerg, and T. Hvelplund, *Danish Institute of Agricultural Sciences, Tjele, Denmark.*

The present study aimed to investigate the metabolism of 1,2-propanediol (PPD; propylene glycol) by studying glucose kinetics and plasma metabolite concentrations in lactating cows without interference from the ruminal microbiota. Three rumen-cannulated cows (14, 20, and 25 kg milk/d) were subjected to three washed reticulo-rumen infusion treatments in a Latin square design. The treatments were control (acetate + butyrate), propionate (control + propionate), and PPD (control + PPD). The absorption rate of each of the metabolites was maintained for 420 min by continuous intra-ruminal infusion of the nutrients into 30 L of bicarbonate buffer placed in the reticulo-rumen. The irreversible loss rate of glucose as well as the relative enrichment of lactate and alanine were measured by GLC-IRMS following intravenous infusion of [U-13C]glucose. The ruminal disappearance of acetate (1,219 $\pm$ 25 mmol/h) and butyrate (210 $\pm$ 4 mmol/h) was not affected ($P > 0.10$) by treatment. With the propionate treatment 730 $\pm$ 23 mmol/h of propionate were absorbed and with the PPD treatment 721 $\pm$ 17 mmol/h of PPD were absorbed. The irreversible loss rate of glucose decreased during the study ($P < 0.001$; the mean decrease was 68 $\pm$ 12 mmol/h). However, the mean irreversible loss rate of glucose (441 $\pm$ 35 mmol/h) was not different ($P > 0.10$) between treatments. The plasma concentration of PPD reached 4.9 $\pm$ 0.6 mmol/L at the end of the intra ruminal infusion indicating that it was not efficiently metabolized under washed reticulo-rumen conditions. Nevertheless, the relative C-13 enrichment of plasma lactate decreased ($P < 0.05$) with the PPD treatment compared with control. It was concluded that PPD had a low metabolizability under washed reticulo-rumen conditions though some PPD apparently was metabolized into lactate. The study also suggested that it is difficult to induce short-term treatment differences in the irreversible loss rate of glucose even in ruminants deprived of the ruminal propionate absorption.

Key Words: Ruminant, Propylene glycol, Metabolism

1594 A comparison between rumen evacuation and gas production techniques in screening forages. H. Z. Taweel, B. Tas, B. A. Williams, J. Dijkstra, and S. Tamminga, *Animal Nutrition Group, Wageningen, The Netherlands.*

This study compares rumen evacuation and gas production as means to screen forages. Eight cultivars of perennial ryegrass (*L*olium perenne) were cut daily at the same age (4 weeks re-growth) and stall-fed to six rumen-cannulated, high-producing, Holstein-Friesian dairy cows in 7 periods of 2 weeks each. Cultivars 7 and 8 were each fed to 3 cows in periods 1, 3, 5, and 7, whereas cultivars 1 to 6 were each fed to one cow in periods 2, 4, and 6 in a 2 (3×3) Latin square design. At the end of the second week, cows were rumen-evacuated twice, and the fractional NDF degradation rate (kd) was estimated using ADL as an internal marker for solid particles passage. Grass samples were also taken, freeze-dried, ground, and fermented for 72 hours using the automated gas production technique. The resulting gas production curves were fitted using dual-pool Logistic and Gompertz models. In these models the second pool is assumed to represent the non-soluble (fiber) fraction, and allows the estimation of the specific fermentation rate of the fiber. The kd based on evacuation was lower than that based on gas production (2.57 VS 5.40 %/h). Moreover, ranking of cultivars was different between techniques. Rumen evacuation showed that cultivars 7 and 8 had faster kd than the other cultivars, whereas, data from gas production showed the opposite as cultivars 7 and 8 had the slowest kd. Rumen evacuation refers to the declining total NDF pool in the rumen and it estimates kd of the total NDF fraction. Whereas, gas production refers to the growing gas pool and it estimates kd of the potentially degradable NDF fraction with the assumption that the rate of gas production is directly proportional to substrate degradation. Moreover, with gas production the second pool is often assumed to represent the fiber fraction, though it actually represents the slowly fermentable fraction, which may or may not be fiber. Therefore, it can be concluded that these techniques are not comparable for these forages.

Key Words: Rumen-evacuation, Gas-production, Degradation rate

1595 Effect of stage of growth on the protein and carbohydrate subfractions of alfalfa and Timothy hay. P. Yu*[1], D.A. Christensen[1], and J.J. McKinnon[1], [1]*Department of Animal and Poultry Science, University of Saskatchewan.*

The two varieties of alfalfa (*Medicago sativa* L. cv. Pioneer, Beaver) and timothy (*Phleum pratense* L. cv. Climax, Joliette) hay grown at three different locations (N=3) were cut at three stages of growth: 1=early bud for alfalfa and joint for timothy; 2=late bud for alfalfa and pre-bloom head for timothy; 3=early bloom for alfalfa and full head for timothy. The objective was to investigate the effect of variety and maturity stage on the degradable crude protein (CP) (PA, PB1, PB2, PB3, PC) and carbohydrate (CHO) (CA, CB1, CB2, CC) subfractions as partitioned by the Cornell Net Carbohydrate Protein System. The results showed that comparing alfalfa and timothy means, alfalfa contained higher ($P < 0.05$) levels of PA (41.5 vs. 16.5 % CP), PB3 (27.2 vs. 21.3 % CP), PC (8.6 vs. 5.2 % CP; $P = 0.08$), CA (36.0 vs. 14.7 % CHO) and CC (35.1 vs. 16.4 % CHO), but lower ($P < 0.05$) levels of PB1 (8.4 vs. 23.6 % CP), PB2 (10.7 vs.33.5 % CP) and CB2 (27.4 vs. 67.6 %CHO). Forage variety had little effect, however, stage of growth influenced both the CP and CHO subfractions, As plant maturity advanced from stage 1 to 3, the rapidly degradable CP fraction (PA) was reduced ($P<0.05$) in alfalfa (51.2 to 34.8% CP), but increased ($P<0.05$) in timothy (9.2 to 27.5% CP); the rapidly degradable CP fraction (PB1) increased ($P<0.05$) in alfalfa (0.0 to 25.2% CP) but decreased ($P<0.05$) in timothy (31.6 to 16.7% CP); the intermediately degradable CP fraction (PB2) was reduced ($P<0.05$) in both forages (alfalfa: 14.1 to 5.2% CP; timothy: 37.8 to 29.4% CP); the slowly degradable CP fraction (PB3) was reduced ($P<0.05$) in alfalfa (33.1 to 17.7% CP) but not in timothy (averaging 21.3% CP); the unavailable CP fraction (PC) was increased ($P<0.05$) in alfalfa (3.5 to 17.1% CP) but not in timothy (averaging 5.2% CP). As plant maturity advanced, CHO subfractions in both forages were impacted to a lesser degree than the CP subfractions. The results indicate that within each forage species, stage of growth has a greater impact than variety on the partitioning of CP and CHO, into factions that vary in availability to fermentation by rumen microbes.

Key Words: Protein and Carbohydrate Subfractions, Forage Quality, Maturity and Variety

1596 Site of digestion when soyhulls replace corn in diets of dairy cows. I. R. Ipharraguerre*, Z. Shabi, J. H. Clark, and D. E. Freeman, *University of Illinois.*

Soyhulls (SH), a by-product of soybean processing, can be used as a replacement for corn grain in dairy cattle diets because of their high content of fermentable fiber. Five multiparous Holstein cows cannulated in the rumen and duodenum that averaged 63 DIM were used in a 5x5 Latin square design to evaluate the substitution of SH for corn in the diet. Diets contained 23% alfalfa silage, 23% corn silage, and 54% concentrate on DM basis. Pelleted SH replaced corn to supply 0, 10, 20, 30, or 40% of the dietary DM. Intakes of DM and OM and OM truly digested in the rumen were unaffected by treatments ($P > 0.05$; mean = 21.6, 20.0, 8.1 kg/d, respectively). The intake of NDF (5.9, 6.3, 7.7, 8.9, and 9.4 kg/d) increased linearly ($P < 0.01$), but the intake of NSC (8.5, 6.7, 6.0, 5.0, and 3.7 kg/d) decreased linearly ($P < 0.01$) as SH increased from 0 to 40% of the dietary DM. As SH replaced corn in the diet, the amount of NDF digested was increased whereas the amount of NSC digested was decreased in the rumen (NDF = 2.6, 2.6, 3.6, 3.6, and 4.2 kg/d, $P < 0.01$; NSC = 1.8, 2.1, 1.0, 0.6, and 0.3 kg/d, $P < 0.01$), in the lower digestive tract (NDF = 0.6, 0.9, 0.9, 1.6, and 1.4 kg/d, $P < 0.04$; NSC = 6.0, 4.2, 4.6, 4.1, and 3.0 kg/d, $P < 0.01$) and in the total tract (NDF = 3.2, 3.5, 4.5, 5.2, and 5.5 kg/d, $P < 0.01$; NSC = 7.8, 6.3, 5.6, 4.6, and 3.3 kg/d, $P < 0.01$). Passage to the duodenum of nonamonnia N, microbial N, nonamonnia nonmicrobial N, total essential AA, total nonessential AA, and total AA were not affected by treatments ($P > 0.05$; mean = 574, 304, 270, 1389, 1665, and 3053 g/d, respectively). Differences in the source of energy (fiber vs. NSC), in the amounts of fiber and NSC digested, and in the site of digestion in the gastrointestinal tract may cause a shortage of energy that decreases milk production when more than 30% of the dietary DM that is supplied as corn is replaced with SH.

Key Words: Soyhulls, Ruminal fermentation, Nutrient digestion

1597 Effects of combinations of crotonate and three methane inhibitors on rumen fermentation in vitro. E.M. Ungerfeld*, S.R. Rust, and R. Burnett, *Michigan State University, East Lansing, MI.*

We hypothesized that the use of crotonate as an electron sink could relieve the constraints on fermentation caused by the CH_4 inhibitors lumazine, propynoate, and ethyl 2-butynoate. In three experiments with 24-h mixed rumen batch cultures, lumazine (0, 0.3 and 0.6 mM, Exp. 1), propynoate (0, 2 and 4 mM, Exp. 2), and ethyl 2-butynoate (0, 4 and 8 mM, Exp. 3), were each incubated in 160 mL Wheaton bottles (n = 4) with crotonate (0 and 8 mM with lumazine, 0 and 4 mM with propynoate acid, and 0 and 4 mM with ethyl 2-butynoate). Ground alfalfa hay was the substrate. Lumazine, propynoate, and ethyl 2-butynoate decreased ($P < 0.01$) CH_4 production by 9, 70, and 94 %, respectively. Crotonate decreased ($P < 0.01$) CH_4 production by 10 % in Exp. 1, and tended ($P = 0.08$) to decrease it by 9 % in Exp. 2, but did not affect it in Exp. 3. There were no interactions between crotonate and any of the inhibitors. Lumazine, propynoate, and ethyl 2-butynoate decreased ($P < 0.01$) fermented OM (as estimated through a mass balance) by 7, 21, and 35 percentage units, respectively. Crotonate did not affect fermented OM in Exp. 1 and 3. In Exp. 2, crotonate stimulated OM fermentation by 5 percentage units at 4 mM propynoate, but dropped it by 6 and 3 percentage units at 0 and 2 mM propynoate, respectively (interaction $P = 0.04$). Crotonate increased ($P < 0.01$) the acetate:propionate ratio (A/P) in Exp. 1. In Exp. 2, crotonate increased A/P at 0 and 4 mM propynate, but not at 2 mM (quadratic interaction $P < 0.01$). Crotonate tended ($P = 0.11$) to increase A/P in Exp. 3. Lumazine increased ($P = 0.02$) A/P, while both propynoate and ethyl 2-butynoate decreased ($P < 0.01$) it. The inhibition of methanogenesis by propynoate and ethyl 2-butynoate caused ($P < 0.01$) the accumulation of H_2, formate, and ethanol. In all the experiments, crotonate increased ($P < 0.01$) butyrate molar percentage. Crotonate did not overcome the decrease in fermentation caused by the CH_4 inhibitors.

Key Words: Rumen, Methane, Inhibition

1598 Effects of natural plant extracts on nitrogen metabolism and fermentation profile in continuous culture. M. Busquet[1], S. Calsamiglia*[1], A. Ferret[1], and C. Kamel[2], [1]*Universitat Autonoma de Barcelona, Spain,* [2]*Axiss France.*

Eight 1.3-L dual flow continuous culture fermenters were used in two periods (10 d) to study the effects of natural plant extracts on N metabolism and fermentation profile. Fermenters were fed 95 g/d of a 60 to 40 forage to concentrate diet. Treatments were: no extract or negative control (C), Monensin (1.75 mg/d per fermenter, M), or 7.5 mg/d per fermenter of Fenugreek (F), Cade (CA), Tea Tree (T), Dillweed (D), Ginger (G) or Clove Bud (CL). Fermenters were maintained at constant temperature (39 C), pH (6.4) and solid (5% / h) and liquid (10% / h) dilution rates. Each day, a sample was taken 2 h after the morning feeding for the determination of ammonia (NH3) N and volatile fatty acids (VFA). During the last 2 days, samples were taken at 0, 2, 4, 6, and 8 h after the morning feeding, and analyzed for peptide (Pep), aminoacid (AA) and NH3 N concentrations. Data were analyzed using the PROC MIXED (SAS, 1996) and significance declared at $P < 0.05$. Total VFA was similar across treatments (111.1 mM). Acetate concentration (mol/100mol) was lower for CL (57.5) compared to C (61.9) and M (61.1). Propionate concentration (mol/100mol) was higher in CL (28.0) versus C (23.2) and M (24.2). The Pep-N concentration across all hours (mg/100ml) was higher for CL (6.93) compared to C (3.84) and M (4.18). The AA-N concentration across all hours (mg/100ml) was numerically lower in CL (2.85) and higher in C (5.27) and M (5.17). The NH3-N concentration across all hours (mg/100ml) was numerically higher in M (9.55) and lower in CL (6.43). The accumulation of Pep-N, and the decrease in AA-N in CL suggested that peptidolysis was inhibited.

Key Words: Microbial fermentation, Plant extract

1599 Influence of grain density on rumen and digestive characteristics. A. Offner*[1], A. Bach[2], and D. Sauvant[1], [1]*INA P-G INRA, Paris, France,* [2]*Agribrands, Barcelona, Spain.*

The effect of technological treatment of cereals on ruminant digestion has been poorly quantified. The objective of this study was to evaluate the interest of using grain density (D) as a predictor of treatment effects. A database on ruminal digestibility in cattle pooled 21 references and 69 treatments studying the influence of grain density. Corn and sorghum were used in 80 % of the references. Treatments were mostly steam flaking and dry rolling and the corresponding grain density ranged from 170 to 684 g/L (D = 389 ± 100 g/L). Statistical analyses of the data used GLM models and integrated the experimental effect as a qualitative variable. The results showed the large effect of density on several key parameters. Decreasing density significantly increased ruminal starch digestibility (Starch dR = 73.7 ± 15.8 %): Starch dR, % = 99.88 - 0.063D (n = 58, n_{exp} = 20, R^2 = 93.2 %, rsd = 5.1 %). Consequently, ruminally fermented organic matter (RFOM = 61.6 ± 12.0 %DM) increased by 21 %DM when density dropped by 100 g/L. Organic matter digestibility in the total tract (dOM = 73.9 ± 8.0 %) increased similarly: dOM, % = 84.04 - 0.025D (n = 46, n_{exp} = 16, R^2 = 93.7 %, rsd = 2.5 %). The treatments had an effect on microbial protein formation (MCP = 73.7 ± 16.5 %DM), which increased when density decreased: MCP, %DM = 83.82 - 0.021D (n = 33, n_{exp} = 12, R^2 = 95.3 %, rsd = 4.5 %DM). Nevertheless, the influence of grain density on rumen pH (pH = 6.0 ± 0.3) was also noticeable: pH = 5.54 + 0.001D (n = 38, n_{exp} = 13, R^2 = 94.4 %, rsd = 0.1). Adjusted pH was under 6 for density below 460 g/L. Grain density is a simple quantitative parameter, which can be used to predict some ruminal parameters. It is concluded that the digestive effects of technological treatments such as steam flaking can largely be captured considering density effects.

Key Words: Rumen, Grain density, Steam flaking

1600 The binding and degradation of nisin by mixed ruminal bacteria. S.S. Lee*[1], H.C. Mantovani[1], and J.B. Russell[2], [1]*Cornell University,* [2]*ARS/USDA.*

Monensin and the bacteriocin, nisin, have similar effects on ruminal fermentation, and bacteriocins have been suggested as another means of altering ruminal fermentation. Because monensin and nisin both catalyze potassium efflux from sensitive bacteria, potassium depletion can be used as an index of sensitivity. Nisin catalyzed potassium efflux from glycolyzing S. bovis cell suspensions, and the steady state concentration of residual potassium was dependent on the amount of nisin added. The relationship between nisin concentration and potassium depletion was a saturation function that had considerable cooperativity. By preincubating mixed ruminal bacteria with nisin and removing them prior to S. bovis JB1 addition, it was possible to estimate the ability of mixed ruminal bacteria to bind or degrade nisin. Low concentrations of mixed ruminal bacteria did not bind or degrade all of the nisin in 6 h, but little nisin remained if the mixed ruminal bacteria were present at more than 50 g protein per ml. Because cell-free ruminal fluid (10% v/v) inactivated the nisin in less than 2 h, and this inactivation could be counteracted by autoclaving, ultra-filtration and proteinase inhibitors it appeared that there was an enzymatic degradation of nisin. Mixed ruminal bacteria degraded nisin rapidly, but this degradation did not prevent potassium depletion from mixed ruminal bacteria. These latter results indicated that nisin binding was faster than nisin degradation. The idea that nisin binding could protect nisin from degradation was supported by the observation that intact nisin could be extracted from mixed ruminal bacteria. These observations support the hypothesis that bacteriocins can be used to modify ruminal fermentation, but further work will be needed to see if these peptides can be produced economically.

Key Words: Rumen, Bacteriocin, Fermentation

1601 A decision support system to evaluate methane and nitrogen emissions from dairy cows. E. Kebreab*, J.A.N. Mills, L.A. Crompton, and J. France, *The University of Reading, Reading, United Kingdom.*

Methane and nitrogen (N) emissions from dairy cattle are major contributors to environmental pollution arising from agriculture. The agricultural industry needs to reduce its emissions considerably, and research has demonstrated that one way to achieve this goal is through dietary manipulation. To this end, a few technical models have been developed to evaluate environmental pollution. However, few if any, combine the effects of more than one pollutant and most are too technical and detailed to be used efficiently by farmers or farm advisors. The objective of this study was, therefore, to integrate published, dynamic models describing methane and N metabolism in the lactating dairy cow, and

present the results with the aid of graphical user interface (GUI). Although the technical models were originally developed using ACSL, the advanced continuous simulation language, they were re-coded in Visual Fortran to harmonize the models. The GUI was written in Visual Basic 6. Comparison of the decision support system (DSS) output with those of the individual models showed that the DSS was able to predict methane and N output with the same degree of reliability as the individual models. The GUI allows the user to enter commonly available information on the diet and obtain results in a spreadsheet format on emission levels for methane and predicted N outputs in urine, feces and milk, and assigns a pollution index. Within a short period of time, the user can optimize a dietary regime which balances the economic cost of the diet and pollution index. Preliminary results have shown that feeding diets based on low degradable energy sources such as corn, significantly reduce methane emissions and shifts the route of N excretion from urine to feces, which is a lesser pollutant. The DSS can also be used to estimate emissions at the farm or national level.

Key Words: Dairy cows, Models, Pollution

1602 The effect of condensed tannins from *Lotus corniculatus* on growth and proteolytic activity of rumen bacteria. B.R. Min*[1], G.T. Attwood[2], T.N. Barry[3], and W.C. McNabb[2], [1]*E (Kika) dela Garza Institute for Goat Research, Langston University, OK 73050, USA,* [2]*AgResearch, Grasslands Research Center, Palm/North,* [3]*Massey University, Palm/North, NZ.*

Eleven strains of ruminal bacteria (*Streptococcus bovis* NCFB 2476 and B315, *Butyrivibrio fibrisolvens* strains WV1 and C211a, *Prevotella ruminicola* 23, *Prevotella*-like strain C21a, *Ruminococcus albus* 8, *Fibrobacter succinogenes* S85, *Eubacterium* sp. C12b and C124b, and *Clostridium proteoclasticum* B316T) were used to determine the effect of condensed tannins (CT) from *Lotus corniculatus* (LC) on the proteolysis of the large (LSU) and small (SSU) subunit of ribulose-1,5-bisphosphate carboxylase (Rubisco) protein extracted from white clover, and on bacterial growth in vitro. The effects of CT were determined with and without polyethylene glycol (PEG; 1.7 mg PEG/mgCT), which binds and inactivates CT. Proteolysis of LSU and SSU of Rubisco (with 1.5 mgCT/ml) was determined in in vitro and measured using a SDS-PAGE procedure. Bacterial growth in a plant protein medium containing 0, 50, 100, 200, 400, and 600 μgCT/ml was also measured after 0, 2, 4, 8, 12 and 24h of incubation. Proteolytic bacterial cultures without CT or with CT+PEG degraded LSU and SSU rapidly (6-38%/h), but proteolysis varied markedly between species. Cultures of P. ruminicola C21a degraded both the LSU (11.3%/h) and SSU (9.8%/h) when grown in the presence of 1.5 mgCT/ml. Bacterial strains S. bovis B315 (11.5%/h) and strain NCFB 2476 (10.6%/h), Eubacterium sp. C12b (5.1%/h) and C124b (5.5%/h) appeared to degrade SSU more effectively than the LSU (2.6, 2.3, 3.8, and 2.6%/h, respectively) in the presence of 1.5 mg CT/ml. *F. succinogenes* S85, *R. albus* 8, *P. ruminicola* 23, *C. proteoclasticum* B316T, *B. fibrisolvens* WV1 and C211a had low (0.3) to moderate (3-4%/h) rates of propeolysis when CT was included in the medium. In the absence of CT, all bacterial strains showed typical growth. Addition of 200, 400 and 600 μgCT/ml significantly ($P<0.05$) reduced the growth rate and maximum optical density of most bacterial strains tested compared to the minus CT controls. Some strains (*C. proteoclasticum* B316T; $P<0.05$ and *R. albus* 8; $P=0.09$), however, showed transient increases in their growth rate at low (50-100μ gCT/ml), but not at higher concentrations. It was concluded that CT from LC reduced the rate of proteolysis and inhibited the growth of proteolytic rumen micro-organisms.

Key Words: Condensed tannins, rumen bacteria, proteolysis

1603 Dose-response effects of intra-ruminal infusion of propionate on feeding behavior of lactating dairy cows in early or mid-stage of lactation. M. Oba* and M. S. Allen, *Michigan State University, East Lansing, MI.*

The objective of this experiment was to evaluate how dose-response effects of intra-ruminal infusion of propionate on feeding behavior and DMI differ by stage of lactation. Six cows in early stage of lactation (EL) and six cows in mid stage of lactation (ML) were used in a duplicated 6 x 6 Latin square design (9 6 and 192 17 days in milk, respectively for EL and ML; mean SD). All cows were ruminally cannulated prior to the experiment. The experimental diet was formulated to contain 30% NDF, and dry cracked corn (mean particle size = 3.6 mm) was the primary source of starch. Infusion treatments were mixtures of sodium propionate and sodium acetate, at ratios of 0:5, 1:4, 2:3, 3:2, 4:1 and 5:0, infused into the rumen continuously for 18 h starting 6 h before feeding at a rate of 21.7 mmol of sodium VFA/min. We hypothesized that propionate infusion decreases DMI by stimulating oxidative metabolism in the liver. We expected greater hypophagic effects of propionate for EL compared to ML because of greater oxidative metabolism of non-esterified fatty acids in the liver for EL compared to ML (plasma concentration: 275 and 76 meq/L, EL and ML, respectively; $P< 0.001$). Propionate infusion decreased DMI for EL and ML, but a quadratic effect of propionate infusion was observed for ML only (interaction $P< 0.10$), indicating greater marginal reduction in DMI at higher doses of propionate for ML compared to EL. Contrary to our hypothesis, propionate infusion linearly increased intermeal interval for ML but not EL, but decreased meal size similarly for both stages of lactation. Greater milk yield for EL compared to ML (42.0 vs. 30.8 kg/d $P< 0.001$) probably increased glucose demand of peripheral tissues and decreased the relative proportion of infused propionate oxidized in the liver, delaying the sense of hunger. Glucose demand of peripheral tissues might alter hypophagic effects of propionate by affecting the extent of oxidative metabolism in the liver.

Key Words: Propionate, Oxidative metabolism, Glucose demand

1604 Monensin by fat interactions on *trans* fatty acid concentrations in cultures of mixed ruminal microbes grown in continuous fermenters fed corn or barley. T. C. Jenkins*[1] and V. Fellner[2], [1]*Clemson University, Clemson, SC,* [2]*North Carolina State University, Raleigh, NC.*

In previous studies, monensin (M) and unsaturated plant oils independently increased *trans* fatty acid concentrations in cultures of mixed ruminal microbes. This study was conducted to determine if combining M with plant oil yielded interactions on *trans* fatty acid concentrations in cultures of mixed ruminal microbes or their effects were additive. Four continuous fermenters were fed 14 g of dry feed per day (divided equally between two feedings) consisting of alfalfa hay pellets (30% of DM) and either a high corn (HC) or a high barley (HB) concentrate (70% of DM) in each of two fermenters. Within each grain type, one fermenter was supplemented with M (25 ppm) and the other fermenter was supplemented with 5% soybean oil (SBO) during d 5 to 8. Monensin and SBO were added together in all fermenters during d 9 to 12. Samples were taken at 2 h after the morning feeding on the last day of each period and analyzed for fatty acids by gas chromatography. A second run of the fermenters followed the same treatment sequence to give additional replication. Average pH across all treatments was 6.15, which was reduced ($P < 0.01$) by M but not affected by SBO. Monensin reduced ($P < 0.05$) the ratio of acetate to propionate, which averaged 2.03 across all treatments; fat decreased the acetate to propionate ratio in cultures not receiving M but increased it in the presence of M. Monensin and SBO altered the concentration of several *trans* fatty acids, but the only interaction was a grain x M x SBO interaction for *trans*-10 C18:1. The increase in *trans*-10 C18:1 by the M and SBO combination exceeded the sum of increases in *trans*-10 C18:1 for each individual feed additive, but only for HB. For the HC diet, M increased ($P < 0.05$) *trans*-10 C18:1 more than fat alone and more than the M and SBO combination. The results of this study show that M and SBO effects are additive for all *trans* fatty acids except for *trans*-10 C18:1. In the case of *trans*-10 C18:1, M and SBO interacted to give higher *trans*-10 C18:1 concentrations in ruminal contents than would be expected simply by adding their individual effects, but only for HB. Because some *trans* fatty acid isomers have been associated with milk fat depression in dairy cows, these results suggest more severe depressions in milk fat content when cows are fed M along with unsaturated plant oils.

Key Words: Monensin, *Trans* Fatty Acids, Continuous Cultures

1605 Utilization of fermentable carbohydrate and protein by ruminal microbes in continuous cultures. K.S. Mohney*[1], V. Fellner[1], A.L. Mueller[2], R.L. Belyea[2], and M.L. Gumpertz[1], [1]*North Carolina State University, Raleigh, NC,* [2]*University of Missouri, Columbia, MO.*

A major factor in maximizing microbial protein synthesis is the availability of energy and protein in the diet. Our objective was to determine the effect of fermentable carbohydrate and protein on microbial fermentation. Diets were formulated using three ingredients, soybean meal

(SBM), ground corn (GC) and soybean hulls (SBH). Corn and SBH were used in ratios of 60:20, 40:40 or 20:60, respectively to prepare high (HC), medium (MC) or low (LC) corn diets. Soybean meal was included either unextruded (control) or extruded at L (L), medium (M) or high (H) temperature. Degradability of the N fractions in the control, L, M and H soybean meal were, 97, 80, 80 and 60%, respectively. Diets were arranged as a 3 x 4 factorial (3 levels of corn/soybean hulls and 4 levels of protein) and analyzed according to a split plot design. Total volatile fatty acids were not affected (P >0.10) by dietary treatments and averaged 70.9 mM across all diets. Diets had no effect on molar ratios of acetate, propionate and butyrate which averaged 60.2, 25.0 and 11.9. Compared to the unextruded SBM, extrusion increased (P <0.10) molar proportion of isovalerate but only in the HC diets. Varying the level of fermentable carbohydrate had no affect on ruminal pH. Extrusion altered pH in the HC and MC diets. In the HC diets both the L and M extrusion temperatures lowered (P <0.05) pH (5.5 and 5.5, respectively) compared to H or the control (5.9 and 5.8, respectively). In the MC diets, the L extrusion temperature resulted in the lowest (P <0.05) pH. Extrusion temperature altered ammonia concentrations. In the LC diets, both L and H increased (P <0.10) ammonia concentration (32.1 and 32.2 mg/dl, respectively) when compared with M and the control (25.6 and 21.0 mg/dl, respectively). Methane concentration averaged 581 nmoles/ml and was not affected by dietary treatment. The HC and MC diets increased (P <0.05) bacterial nitrogen percentage (9.4 and 9.5%, respectively) compared to the LC diet (8.3%). Data suggest that the fermentability of the structural carbohydrates in SBH was similar to the high starch corn diets. Furthermore, large differences in protein degradability did not seem to have a major impact on microbial fermentation.

Key Words: Fermentable carbohydrate, Extrusion, Fermenters

1606 Ruminant N intestinal digestibility estimated by mobile bag or "in vitro" technique.

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Same batch wet and dried brewers grain (WBG, DBG), sorghum distillers grains (SDG) and alfalfa hay (AAH) nitrogen intestinal digestibilities estimated by mobile bag technique (MB) or pepsin+pancreatin digestion (P+P) were compared. Fourteen polyester bags (6 x 7 cm) containig samples of each feed were incubated (16 h) in rumen of three dry Holstein cows, two with duodenum cannulas, individually cofined and fed (8am and 5 pm) 10 kg DM alfalfa hay. After incubation, bags were placed (2.5 h) in acid pepsin-HCl solution (pH 2; 3g pepsin /L 0.1N HCl) in shaking water bath (38.5°C). Bags were then randomly assigned to intestine digestion or "in vitro" pancreatin incubation, 10 and 4 bags/feedstuff, respectively. Ten bags / cow (2 feedstuffs/day) were introduced (evening meal) into small intestine and recovered from from 8am to 5pm following day feces. For pancreatin digestion, bags were incubated (24h; 0.5M KH2PO4 pH 7.8 solution, containing 50 ppm thymol and 3g/L pancreatin) in shaking water bath (38.5°C). Feces recovered or pancreatin digested bags were machine washed (60 bags/washing batch, 45 min). Rumen undegraded N was estimated from six bags/feedstuff incubated for 16h. Intestinal N digestibility was residual N in bags after intestinal or pancreatin incubation / undegraded N . Differences in N digestibilities resulted from: a) amounts DM after total digestion and proportion final DM / initial DM, which were higher in P+P than MB, and b) N concentration in final DM, although not patern was observed. Results suggest pancreatin digestion cannot replace small intestine incubation.

	WBG	WBG	DBG	DBG	SDG	SDG	AAH	AAH
	MB	P+P	MB	P+P	MB	P+P	MB	P+P
Initial DM, g	0.59	0.93	1.50	1.42	1.36	1.36	1.38	1.32
Initial N, %	4.52	4.52	5.78	5.78	5.14	5.14	3.30	3.30
Undegraded N, %	20	20	48	48	51	51	40	40
Final DM, g	0.23	0.65	0.50	0.83	0.24	0.53	0.52	0.65
Final N, %	0.69	0.76	0.91	1.68	4.71	2.55	1.07	0.93
N "intestinal" digestibility, %								
Mean	70 a	41 b	89 a	65 b	68 a	63 a	69 a	65 a
SD	3.7	2.6	1.2	3.6	7.1	0.7	8.1	3.8

a,b : values with equal subscript did not differ (P≥0.0001)

Key Words: Dairy cows, Intestinal digestibility, Mobile bag technique

1607 Development of a real-time quantitative PCR assay to control the yield of DNA extracted from rumen content samples spiked with an exogenous bacteria.

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Recent quantitative PCR-based technologies are now currently used to study rumen microbial ecosystems. They permit to quantify specific rumen bacterial species. We have developed a real-time quantitative PCR assay (TaqMan technology from Applied Biosystems) to normalize for differences in efficiency of DNA extraction and purification from rumen content samples. For this purpose, known amounts of a bacterium not found in the rumen, *Thermus aquaticus*, were added into rumen content samples before DNA extraction. A primer pair and an internal probe were designed based on small subunit ribosomal DNA sequences that were specific to the Thermus strain used. No signal was obtained when using unspiked rumen content samples, suggesting that the designed set of oligonucleotides could not anneal to any other DNA found in the rumen. Results revealed a typical logarithmic amplification of DNA (correlation factor (R^2) of 0,994) from TaqMan PCR assays when using rumen content samples that were spiked with 2 x 10^6 to 2 x 10^8 *Thermus aquaticus* cells as DNA templates. A number as low as 14 cells of Thermus aquaticus could be detected using these assays. In addition to the normalization of the efficiency of DNA extraction and purification, the development of this assay will serve as a tool to correct for the presence of any possible substances interfering with the PCR process such as humic acids. A more precise picture of the rumen ecosystem and dynamics could be obtained when the exogenous bacteria, *Thermus aquaticus*, is used to spike rumen content samples.

Key Words: Rumen, PCR technology, Bacteria

1608 Digestion kinetics of pasture and forage mixed rations prepared by mincing fresh material.

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New Zealand dairy cows are grazed on ryegrass (*Lolium perenne*) dominant pasture (P) as a sole diet but production is constrained by intake and nutrient balance (high bulk and fibre content) and by P availability in summer. The study used *in sacco* incubations to define digestion kinetics of P and mixtures of P with either maize silage (M) and sulla silage (S) or mixtures of all three. Sulla is a low fibre biannual legume containing condensed tannins able to reduce protein degradation. Dry matter (DM) digestion kinetics are presented here. Ten ruminally fistulated cows were fed 5 diets (two cows/treatment) to measure *in sacco* digestion of either P or the particular forage mixed ration (FMR) on which the cows were fed. The rations were (%DM basis): 100P (P); 60P, 40M (PM); 60P, 40S (PS); 60P, 25M, 15S (PMS); 60P, 25S, 15M (PSM). Feeds used for incubation were prepared by mincing fresh (frozen) forages to achieve a particle size distribution similar to chewed material. Duplicate dacron bags containing 5 g DM of P and FMR were removed at 0, 2, 6, 9, 12, 24, 48 and 72 h, washed and dried at 60 °C for 48 h. Reference internal standards were used to adjust for variability between cows. The effects of animal, *in sacco* contents and host animal diet on rumen degradation were examined using a non-linear model with a ruminal rate of passage of 0.06 h^{-1}. A GLM model of variance-covariance was used for statistical analysis. Data show highest degradation rates (k, h^{-1}) when cows were fed PS (P<0.001); diets with a high proportion of maize silage were degraded more slowly. Supplementation with sulla may increase digestion rate and rumen clearance and reduce the effect of fibre in ryegrass diets. These data will be used in a dairy nutrition model (CNCPS) to develop strategies to increase milk production from pasture based grazing systems and predictions will be evaluated against animal feeding trials.

	Pasture		Diet	
Cow diet	k	SE	k	SE
P	0.068	0.003	0.068	0.003
PM	0.058	0.004	0.053	0.002
PS	0.071	0.002	0.085	0.002
PMS	0.066	0.003	0.052	0.004
PSM	0.059	0.004	0.072	0.004
p	<0.0001		0.0069	

Key Words: *In sacco*, forage

1609 Evaluation of dry matter disappearance of roughage sources alone or in combination with ground corn for ruminants. G.V. Pollard*[1], K.F. Wilson[2], C.R. Richardson[3], and T.C. Bramble[3], [1]*Southwest Texas State Univ., San Marcos,* [2]*Loveland Industries, Greeley, CO,* [3]*Texas Tech Univ., Lubbock.*

The objective of this research was to determine the dry matter digestibility (DMD) of roughage sources commonly used in ruminant feeding operations by five different methods: in vitro DMD (IVDMD), Ankom Daisy IVDMD (ADDMD), in situ DMD (ISDMD) in both nylon bags (NB) and Ankom F57 bags (AB), and gas production (GP). Dietary treatments were rice hulls (RH), peanut hulls (PH), cottonseed hulls (CH), soybean hulls (SH), corn (C), or a 40% corn and 60% RH, PH, CH, or SH mixture. All dietary treatments were ground through a 1 mm screen and .5 g samples were used for each incubation method. The ISDMD was determined with AB or NB incubated in the rumen of a cannulated steer fed a roughage diet. All evaluations were conducted at 24 and 48 h. Incubation at 48 h improved ($P < 0.01$) DMD compared to 24 h for all dietary treatments. Within dietary treatment IVDMD produced the highest ($P < 0.01$) DMD, while ISDMD using AB produced the lowest DMD, with ISDMD using NB and ADDMD being intermediate for all dietary treatments. Regardless of the method used RH had lower ($P < 0.01$) overall DMD than other roughage sources, and RHC had lower ($P < 0.05$) DMD than other combination treatments. Addition of C to the roughage sources improved ($P < 0.01$) DMD of all sources. Soybean hulls had the greatest ($P < 0.01$) DMD for all methods compared to other dietary treatments, except SHC or C. Cottonseed hulls had greater ($P < 0.05$) DMD than PH as estimated by IVDMD, however, PH had greater ($P < 0.05$) DMD than CH when estimated by ADDMD, ISDMD with NB, or ISDMD with AB. Gas production proved to be ineffective in estimating DMD for RH, PH, or CH. These results indicate that the addition of C to low quality roughage sources improves digestibility, however, SH alone had greater DMD than combinations of C and RH, PH, or CH. Replacement values of rice hulls, cottonseed hulls, peanut hulls, and soybean hulls are not equal when considering rumen digestibility.

Key Words: Roughage, Hulls, Dry matter disappearance

1610 Influence of rinsing technique and sample size on in situ protein degradation of protein sources. K.M. Whittet*, K.W. Creighton, K.J. Vander Pol, G.E. Erickson, and T.J. Klopfenstein, *University of Nebraska, Lincoln, NE.*

Four experiments evaluated the effect of in situ bag rinsing technique and sample size on undegraded intake protein (UIP) and dry matter disappearance (DMD) of soybean meal (SBM) and Soypass, heat-treated soybean meal. The objective was to determine a rinsing technique and sample size that reduced variation in UIP. Experiments 1 and 2 evaluated the effect of 5 rinsing techniques (2 hand rinsing techniques and 3 machine rinsing techniques with 3, 5, and 8 rinses) after 16 h incubation, with 5 g per bag. Experiments 3 and 4 evaluated the effect of 5 sample sizes (5, 10, 20, 30, and 50 g of sample per bag). Experiments 1 and 3 utilized a feedlot diet with 7.5% roughage, while Exp. 2 and 4 utilized a mixed diet (70% forage:30% concentrate). Samples were unground and weighed into 10 x 20 cm dacron bags with a 50-μm pore size. Run was used as a repeated rinse within day or steer. Effects of steer, day, and run were also examined: Exp. 1 day and run; Exp. 2 steer and run; Exp. 3 steer and day; and Exp. 4 day and run. Three replicate bags within steer within day within run were used. There was a sample effect across all experiments ($P<0.01$). SBM had higher DMD and lower UIP values than Soypass and higher variance for UIP. A steer effect was noted for experiments with steer as a replication ($P<0.01$). Steer had a larger effect than day with an F-statistic of 243.5 and 8.6, respectively. In Exp. 3, the F-statistic for steer was 146.2 and day in Exp. 4 was 4.4. Rinse and size were not significant ($P=0.85$) in concentrate fed steers (Exp. 1 and 3) but were ($P<0.01$) in mixed diet steers. There was a rinsing effect ($P<0.01$) in Exp. 2, with 8 machine rinses having higher DMD and lower UIP values. Size effect ($P<0.01$) was noted for Exp. 4, with 50 g having the lowest DMD and highest UIP values. Steer contributed a larger effect than day. There is no difference between hand and machine rinsing, but with increased rinsing, washout can occur. Based on the effects, a mixed diet is a better model for in situ incubation.

Key Words: In Situ, Protein, Undegraded Protein

1611 Influence of buffer pH and biotin addition on forage fiber digestibility in vitro. O Rosendo*[1], D Bates[1], C. R. Staples[1], R. J. McMahon[1], and L. R. McDowell[1], [1]*University of Florida.*

The objective of these studies was to determine if supplemental biotin would overcome the negative effect of low pH on NDF digestibility. In the first study, the effect of media pH on fermentation pH across a 24 h period and at 39 C was tested. Standard artificial saliva (pH = 6.9) was made more acidic (pH = 6.7 and 5.5) by modifying the $NaH_2PO_4.H2O$, Na_2HPO_4, and $NaHCO_3$ concentrations. Each artificial saliva was added to rumen fluid at a ratio of 4:1 and then to a substrate of corn silage (0.25 g as-fed). The pH of fermentors decreased by 0.34, 0.17, and 0.13 pH units for the 5.5, 6.7 and 6.9 initial buffer pH, respectively. In the second study, only artificial saliva with initial pH of 5.3 or 6.7 were used to carry out in vitro incubations of alfalfa hay, bermudagrass hay and corn silage (0.25 g as-fed per substrate) with the same conditions as before. Either one ml of distilled water or d-biotin (Sigma, St. Louis, MO) in aqueous solution was added to each tube to supply 0, 10, or 20 μg biotin/26 ml of total incubation fluid. Three tubes for each biotin concentration by forage source were incubated. Blanks for each substrate were included to correct for NDF provided by the inoculum. Three experiments (runs) were conducted in different weeks. Ash-free NDF was determined at 24 h of fermentation. The extent of NDF digestibility (ENDFD) was analyzed using the general linear models procedure of SAS. The model included factors for run, forage, biotin concentration, pH, and interactions. An interaction of biotin by pH by forage on ENDFD ($P = 0.071$) was observed. For corn silage, the addition of 20 μg of biotin stimulated ENDFD at pH 6.7 (36.4, 35.4, and 38.1% for 0, 10, and 20 μg of biotin, respectively) but depressed ENDFD when the pH was 5.3 (11.3, 11.7, and 6.9% for 0, 10, and 20 μg of biotin, respectively). The ENDFD of the alfalfa and bermudagrass hay were markedly reduced by the lower buffer pH but did not change with biotin addition. Results did not support the hypothesis that supplemental biotin would reduce the depression of fiber digestibility caused by low ruminal pH.

Key Words: Biotin, Fiber digestibility, pH

1612 Comparison of in vitro and in situ methods for measuring dry matter disappearance of ruminant fiber sources. G.V. Pollard[1], K.F. Wilson[2], T.C. Bramble*[3], and C.R. Richardson, [1]*Southwest Texas State Univ., San Marcos,* [2]*Loveland Industries, Greeley, CO,* [3]*Texas Tech Univ., Lubbock.*

The objective of this research was to evaluate in vitro (IV) methods, DAISY^{II} (AD), Tilley and Terry method (TT) and in situ (IS) methods using nylon bags (NB) or Ankom F57 bags (AB) to determine the DM disappearance (DMD), and gas production (GP) of roughage sources commonly used in ruminant diets. Feed sources were ground to pass a 1-mm screen and consisted of rice hulls (RH), peanut hulls (PH), cottonseed hulls (CH), soybean hulls (SH), corn (C), or a 40% corn and 60% RH, PH, CH, or SH. Standard procedures, chemicals, and ruminal inoculum amounts were utilized for each IV method. Gas production was determined by incubating 0.5 g of each feed source in 50 mL of TT ruminal fluid and buffer mixture, and recording mL of gas produced per g DM. In situ DMD was conducted utilizing standard procedures except, in addition to NB, AB were also evaluated to determine whether they could replace NB in IS evaluations. Of all methods tested, GP was the least effective for estimating DMD of lowly digestible fiber sources (RH, PH, CH). Milliliters of gas produced was similar among all three fiber sources; however, DMD as estimated by IV or IS methods differed ($P < 0.05$) by greater than 121%. In situ DMD estimated using AB consistently produced the lowest ($P < 0.01$) DMD. Among all methods compared, TT produced the greatest ($P < 0.05$) DMD, with AD being greater ($P < 0.05$) than IS with NB, while IS with AB had the lowest DMD. This pattern was also the same when compared among individual fiber sources, except for PH, which had similar ($P > 0.05$) DMD for TT, AD, and ISNB. Results of this study indicate that gas production and in situ DM disappearance using Ankom F57 bags are poor indicators of DM disappearance as indicated by traditional in vitro or in situ procedures. The Tilley and Terry method likely produced the greatest disappearance due to a higher concentration of ruminal fluid used in the inoculum as compared to DAISY^{II}.

Key Words: Dry matter disappearance, In vitro, In situ

1613 Evaluation and refinement of ruminal volatile fatty acid absorption equations in a dynamic, metabolic model of the lactating dairy cow. M. D. Hanigan*, D. C. Weakley, F. Standaert, and L. R. Reuzel, *Purina Mills, LLC, St. Louis, MO.*

Kohn et al. (1994) previously observed that ruminal volatile fatty acid (VFA) concentrations were not well predicted by the model of Baldwin et al. (1995). The objective of this work was to further evaluate the model and to undertake corrective changes if warranted. Model evaluations were conducted using treatment means for a data set comprised of 17 experiments and 69 dietary treatments. Diets were primarily dairy-type diets with varying nutrient profiles, however, one experiment consisted of low-forage feedlot rations. The model of Baldwin (1995) predicted total VFA, acetate, propionate, and butyrate concentrations with root mean square prediction errors (RMSPE) of 37.8, 46.7, 19.0, and 29.1% of the mean observed values, respectively. Fitting rate constants for fiber hydrolysis and VFA absorption to the data set reduced RMSPE to 11.8, 11.3, 17.0, and 21.8%, respectively. However, RMSPE for duodenal flows of cellulose and hemicellulose increased from 17.4 and 30.2% to 22 and 33.9%, respectively. Additionally, residual errors for acetate and butyrate concentrations contained significant slope bias that appeared to be associated with ruminal pH suggesting that the lack of consideration of pH effects by the absorption submodel was inappropriate. The VFA absorption model of Dijkstra et al. (1993) utilizes VFA concentration and pH as determinants of absorption rates. Adoption of that submodel resulted in RMSPE of 7.9, 10.1, 26.9, and 13.2%, respectively. Analyses of propionate residuals indicated that pH prediction errors were at fault. Adoption of a revised pH prediction equation resulted in RMSPE of 11.9, 12.8, 11.9, and 12.8 for total VFA, acetate, propionate, and butyrate predictions, respectively, and RMSPE for predictions of duodenal cellulose and hemicellulose flows of 20.4 and 28.0%, respectively. Changes undertaken appear to have improved predictions of ruminal propionate and butyrate without negatively affecting predictions of fiber digestion.

Key Words: model, rumen, volatile fatty acids

1614 Nucleic acid content and profile of protozoal and bacterial fractions isolated from ruminal contents of lactating dairy cows. L. T. Mydland* and H. Volden, *Agricultural University of Norway.*

The main objective of this study was to compare the nucleic acid base composition of liquid-associated protozoa (LAP), liquid-associated bacteria (LAB) and solid-adherent bacteria (SAB). Three cannulated multiparious dairy cows were used in a 3 × 3 Latin square experiment to study the proportion of red clover in grass silage. Dietary treatments were (1) solely timothy, (2) 23 % red clover, and (3) 46 % red clover. Protein content (g/kg DM) in silage was (1) 149, (2) 166 and (3) 182 and NDF content (g/kg DM) was (1) 567, (2) 485 and (3) 402. Cows were fed a 70:30 ration based on silage and a barley/oats based concentrate mixture four times daily. The microbial fractions were isolated from the rumen at 0530, 0800 and 1000. Nucleic acid bases (NAB) in microbes were determined by HPLC after hydrolysis with perchloric acid. Microbial nitrogen content (g/kg DM) was affected by diet ($P < 0.1$) and averaged 72.5, 74.1, and 74.5 for diet 1, 2 and 3, respectively. However, the NAB:N ratio was not affected by diet composition. The microbial fractions harvested at 0800 (two hours post-feeding) showed a higher ($P<0.05$) content of total-NAB, Adenine, Cytosine, Guanine and Uracil than when isolated before feeding and 4 h post-feeding. The present results demonstrated that sampling time has an effect on the NAB content of the rumen microbes. The composition of NAB was different among microbes, and it is concluded from this study that microbial reference sample will have an effect on estimated microbial protein synthesis.

	LAP	SAB	LAB	SEM
Nitrogen, g/kg DM	72.4^a	74.1^b	74.5^b	0.7
Total NAB:N[1]	13.0^a	13.6^a	16.6^b	0.3
Adenine[1]	5.7^a	5.0^b	6.1^c	0.1
Cytosine[1]	1.2^a	1.8^b	2.4^c	0.05
Guanine[1]	4.3^a	4.8^b	6.0^c	0.1
Thymine[1]	0.5^a	0.5^a	0.6^b	0.02
Uracil[1]	1.4^a	1.4^a	1.6^b	0.04

[1] gram NAB-nitrogen 100 g^{-1} nitrogen. ^{a,b,c} Means in rows with different superscripts differ ($P < 0.05$).

Key Words: Rumen microbes, Nucleic acid bases, Grass silage

1615 Effects of rumen degradable protein and fiber quality on microbial growth, digestion, and fermentation in continuous culture. K. E. Griswold*, D. L. Hastings, B. N. Jacobson, J. Salazar, and G. A. Apgar, *Southern Illinois University, Carbondale, IL.*

The effects of rumen degradable protein (RDP) and fiber quality on microbial growth, digestion, and fermentation were examined using a 4 x 4 Latin square with a 2 x 2 factorial arrangement of treatments in dual-flow continuous culture. Factors were level of RDP and quality of fiber, and the treatments were: 1) high RDP (12.4% of dietary DM), high quality alfalfa (156 RFV) (HPHF); 2) high RDP (12.4% of dietary DM), low quality alfalfa (105 RFV) (HPLF); 3) low RDP (10.4% of dietary DM), high quality alfalfa (156 RFV) (LPHF); and 4) low RDP (10.4% of dietary DM), low quality alfalfa (105 RFV) (LPLF). Periods were 10 d with 7 d for equilibration and 3 d for sampling. Data were analyzed using SAS GLM procedures with the model including period, fermentor, RDP, fiber quality, and the RDP x fiber quality interaction. Increasing dietary RDP significantly increased microbial N flow (g/24 h), and tended to increase N degradation %, NH_3-N (mg/dL), nonammonia, nonmicrobial N (NANMN), and microbial efficiency (g N/kg OM digested). Microbial N (% of microbial DM) was 7.86, 6.27, 6.51 and 5.75 for HPHF, HPLF, LPHF, LPLF, respectively, and tended to increase with increased fiber quality ($P<0.10$). The RDP x fiber quality interaction significantly increased DM and OM digestibility of HPHF compared to the other treatments ($P<0.05$). Increasing dietary RDP significantly increased NDF, hemicellulose, and ADF digestibility ($P<0.02$). Increasing fiber quality from 105 to 156 RFV tended to increase ADF digestibility ($P=0.078$), but did not alter NDF or hemicellulose digestibility. Propionate molar percentage significantly decreased ($P=0.007$) and total VFA (mM) tended to decrease ($P=0.081$) as fiber quality increased while acetate and isovalerate molar percentage tended to decrease ($P<0.10$). These results suggest that peptides and AA released from increased dietary RDP increased hemicellulose and NDF digestibility regardless of fiber quality of the diet.

Key Words: RDP, Fiber quality, Continuous culture

1616 Comparative kinetic of dry matter ruminal degradation of alfalfa hay and clitoria hay (Clitoria ternatea) in sheep. R. Barajas*[1], M. Placencia[1], A. Estrada[1], and J.F. Obregon[1], [1]*FMVZ-Universidad Autonoma de Sinaloa (Mexico).*

With the objective of compare the kinetic of dry matter ruminal degradation of alfalfa hay and clitoria hay (Clitoria ternatea) in sheep, an experiment was conducted. Four Pelibuey sheep (Females; BW = 32 kg), fitted with ruminal cannula (ID = 5 cm) were used in a complete randomized design experiment. Animals were placed individually in metabolic crates (0.6 x 1.2 m), fed (3% of BW) a 14% CP ration, containing 25% alfalfa hay (AH), 25% clitoria hay (CH) and 50% concentrate. Fifty six Dacron bags (10 x 18 cm) were filled with 5.5 g of alfalfa hay, another fifty six bags were filled with clitoria hay (5.5 g), randomized were grouped in 28 set of four bags (AH 2 bags and CH 2 bags); set of bags were assigned to one of six incubation times (3, 6, 12, 24, 48, and 72 hours) in rumen of sheep. Solubility was measured placing bags in warm distilled water (39 C) five minutes. After incubation bags were washed, oven dried (110 C; 24 hours) and weighed, and dry matter disappearance was calculated and kinetics parameters and effective degradation were performed. DM solubility was similar ($P > 0.10$) for AH (27.65%) and CH (26.66%), respectively. Dry matter disappearance from bags were not affected ($P > 0.05$) by treatments in all rumen incubation times, except for 48 h incubation time, where AH was higher

(P = 0.03) than CH (62.02 vs. 58.07%). Kinetics of rumen degradation of DM was described by the equation P = 26.03 + 31.76 (1 - e-0.14t). Effective ruminal degradation were similar (P > 0.10) with values of 51.6% and 49.4% for HA and CH, respectively. This data suggest that degradation that suffers dry matter of clitoria hay in the rumen, is similar to exhibits by alfalfa hay, and consequently clitoria can be used as alfalfa substitute in tropical regions where is an available feed resource.

Key Words: Alfalfa, Clitoria ternatea, Rumen degradation, Dry matter, Sheep

1617 Effect of extracting soluble proteins on estimates of in situ and in vitro degradability. Y.-G. Goh*[1] and G. A. Broderick[2], [1]*Kangwon National University, Chunchon, South Korea,* [2]*U.S. Dairy Forage Research Center, Madison, WI.*

In situ procedures may overestimate microbial degradation because soluble protein, that still can escape the rumen, is assumed to be degraded when it is solubilized. Effect of extracting soluble proteins on the ruminal degradabilities was assessed in four protein sources: solvent soybean meal (SSBM), expeller soybean meal (ESBM), blood meal (BM) and corn gluten meal (CGM). Ground (Wiley mill, 2 mm screen) samples of each were either unprocessed or extracted for 16 h in McDougall#s buffer (70 g protein source/L buffer) at 39 C. Extracts were filtered (Whatman no. 1 paper) and residues dried (48 h; 60 C) and ground (2 mm). Ground, extracted samples were sieved and particles > 0.5 mm retained for in situ and in vitro studies. Extracted proteins were added to dacron bags; bags were soaked in buffer then inserted into the rumens of two cannulated cows. Duplicate bags for each protein were removed after 0 (washed only), 4, 8, 12, 16, 24, 48, 72, and 96 h of incubation, then washed, dried (24 h, 60 C) and residues ground (2 mm). Mixed microbes were isolated from ruminal contents from the cows; in situ residues and mixed microbes were analyzed for total N and purines. The inhibitor in vitro (IIV) procedure also was used to determine rate and extent of ruminal degradation of both unprocessed and extracted proteins. As expected, there were wide differences (P < 0.01) among proteins in degradation rate (ranging from 0.02/h (CGM) to 0.08/h (SSBM) by in situ, and from 0.01/h (BM) to 0.11/h (SSBM) by IIV) and estimated ruminal escape (ranging from 42% (SSBM) to 75% (BM) by in situ, and from 36% (SSBM) to 90% (BM) by IIV). There were trends (P = 0.08) for more rapid in situ rates with unprocessed than extracted proteins and with the use of the microbial correction. However, estimated escapes were not affected by protein extraction (P = 0.17) or by microbial correction (P = 0.38). Buffer extraction did not alter rates (P = 0.37) or escapes (P = 0.42) estimated by the IIV method. Moreover, degradation rates (P = 0.12) or ruminal escapes (P = 0.52) did not differ between the in situ or IIV method. These results suggest that rapid loss of soluble proteins during in situ incubations does not excessively inflate estimates of ruminal protein degradation.

Key Words: In situ incubation, IIV method, Ruminal degradability

1618 Nutritive value of ground and expanded yellow corn determined in digestibility trials with sheep. N.M. Rodriguez[1], E.N. Rodrigues[1], G.L. Teixeira[1], I. Borges[1], E.O.S. Saliba[1], and L. Goncalves[1], [1]*Federal University of Minas Gerais, Belo Horizonte - MG/ Brazil.*

The nutritive value of ground and expanded yellow corn in diets with tifton hay (Cynodon spp.) was determined using a randomnized 4x2x5 factorial design (four levels x two processings x five replicates) in an apparent digestibility trial with sheep. Four levels of ground and expanded corn (Sprout Matador expander) were used, 0% (A); 19% (B); 37% (C) and 62% (D) (dry basis), and the intake was limited to a maximum of 1.5 maintenance. Expansion slightly decreased NDF of corn (4%) and non fibrous carbohydrates (NFCOH) (6%) with a proportional increase of crude protein. Crude protein and FDN of tifton hay were 10.4 and 76.9%, respectivelly. Expansion increased 35% crude protein digestibility of the diet in treatment D (p<0.05, SNK test), however, decreased digestibility of fibrous components (FDN, celulose, hemicellulose) from about 70% in treatment A to 48% in treatment D. Digestibility of fibrous components of the diets with ground corn were not affected (around 70%). Digestibility of gross energy followed a quadratic model, where y = 64.8927 + 0.7939X # 0.01109X2 for expanded corn (r = 0.80), and y = 66.4852 + 0.4294X # 0.0050X2 for ground corn (r = 0.78). The inflection points of the curves were at 36% and 43% of inclusion in the diets of expanded and ground corn respetivelly. Up to those levels of inclusion in the diets, the digestible energy of ground corn was calculated to be 3.89 Mcal/kg DM, and for expanded corn 5.31 Mcal/kg DM, which means an increase of about 37%. The digestible energy of the hay was 2.8 Mcal/kg DM. Nitrogen balance was positive in all treatments and increased as corn increased in the diet but it was higher in treatments with expanded corn (p<0.05).

Key Words: Expanded Corn, Ground Corn, Nutritive Value

1619 Comparative ruminal degradation of dry matter of alfalfa hay, peanuts hay, and common beans hay from cultivars for green beans, using nylon bag technique in sheep. R. Barajas*[1], A. Estrada[1], and J.F. Obregon[1], [1]*FMVZ-Universidad Autonoma de Sinaloa (Mexico).*

With the objective of comparative ruminal degradation of dry matter of alfalfa hay, peanuts hay (Arachis hipogea L.), and common beans hay (Phaseolus vulgaris L.) from cultivars for green beans, using nylon bag technique in sheep, one experiment was conducted. Three Pelibuey sheep (Males; BW = 33.5 kg), fitted with ruminal cannula (ID = 5 cm) were used in a complete randomized design experiment. Animals were placed individually in pens (1.5 x 2.5 m), fed chopped alfalfa hay having free access to drinking water and a mineral salt. Dacron bags (10 x 18 cm) were filled with 5.5 g of alfalfa hay (AH), peanuts hay (PH) or beans hay (BH), randomized were grouped in 18 set of six bags (AH 2 bags, PH 2 bags, and BH 2 bags); set of bags were assigned to one of five incubation times in rumen of sheep (4, 8, 12, 24, and 48 hours). Solubility was measured placing bags in warm distilled water (39 C) five minutes. After incubation bags were washed, oven dried (110 C; 24 hours) and weighed, and dry matter disappearance and kinetics parameters were performed. Peanut hay was less soluble (P < 0.01) that AH (26.3 vs. 16.4%), and ruminal degradation of PH was lower (P < 0.01) that AH in all incubation times, with values of 71.4 and 52.9% at 48 h for AH and PH respectively. Common beans hay DM was more soluble (P < 0.01) than AH DM (26.3 vs. 37.4%). Beans hay was consistently more degradable in rumen (P < 0.01) than AH in all incubation times tested, with mean value of 71.4% and 81.8% at 48 hours in rumen for AH and BH, respectively. Equation that describes rumen kinetics were: Alfalfa hay = 25.583 + 46.123 (1 - e -0.159 t), R2 = -0.94; peanut hay = 15.196 + 39.533 (1 - e -0.10 t), R2 = -0.94; and beans hay = 37.496 + 43.9 (1 - e -0.174 t), R2 = -0.96. This results suggest, that peanut hay is 37% less degradable in rumen than alfalfa, and the fact that commom beans hay is 9% faster degradable in rumen than alfalfa may keep some relation with presence of bloat.

Key Words: Peanut hay, Beans hay, Alfalfa hay, Rumen, Sheep

1620 Effects of nitrogen type and level on *in vitro* digestion, VFA production and gas yield. K.J. Harvatine* and P.H. Doane, *ADM Alliance Animal Nutrition.*

Nitrogen form and level may affect fiber digestion and yield of gas and VFA. *In vitro* fermentations were conducted in 300 mL serum bottles with 300 mg of isolated corn silage NDF (CS) or alfalfa, with and without addition of 150 mg of starch. Cumulative gas volume was recorded every half-hour and gas curves fit to a two pool logistical model for rate calculation. Digestibility and fermentation products were measured at 24 h. Fermentations were replicated six times, three replicates tested a high quality alfalfa (21.6% NDF, ALF1) and three tested a moderate quality alfalfa (47.4% NDF, ALF2). Nitrogen concentration and sources for treatments where: no nitrogen added (1), 8 mM from urea (2), 16 mM from urea and ammonia (3), 16 mM from urea and tryptone (4), 38 mM from urea, ammonia and tryptone (5), and 38 mM from urea, ammonia, tryptone and branched chain AA (6). Addition of starch significantly decreased NDF digestion in CS and Alf1 (5.1 and 6.3%), but not with Alf2. Starch addition increased the rate and volume of gas produced, and total VFA concentration (P<0.05). Source of nitrogen (3 vs 4) had no effect on NDF digestion, 24 h gas volume, VFA production or VFA profile. Treatment 5 increased NDF digestibility (4.79 and 3.14%, P<0.003) and VFA production (12.4 and 8.0 mM, P<0.004) compared to treatments 3 and 4. Nitrogen treatment interacted with starch addition. Digestion of NDF and 24 h gas production without starch were not different among treatments 3, 4 and 5 although total VFA concentration tended to increase in treatments 4 and 5. With addition of starch, treatment 5 increased NDF digestibility (50.2 vs 44.2

and 46.0%) and VFA concentration (116.9 vs 104.7 and 103.4 mM) relative to treatments 3 and 4, with no increase in gas volume (77.8 vs 77.9 and 75.5 ml). Starch addition reduced fiber digestion. There were no apparent differences between use of ammonia or tryptone in the 16 mM N treatments. Increasing true protein, as shown in treatment 5, altered digestion particularly when starch was added to the fermentation.

Key Words: Gas production, Fiber digestion, Degradable nitrogen

1621 Evaluation of quillaja extract, quebracho tannin and safflower oil as selective defaunating agents in cattle. J. Baah*[1], A.N. Hristov[2], T.A. McAllister[1], M. Ivan[1], K.M. Koenig[1], and L.M. Rode[3], [1]*Agriculture and Agri-Food Canada, Lethbridge, AB,* [2]*University of Idaho, Moscow,* [3]*Rosebud Technology Development, Lethbridge, AB.*

Rumen protozoal populations and fermentation characteristics were assessed in four cannulated Jersey heifers fed quillaja extract (QE, 60 g/d), quebracho tannin (QT, 6 g/kg diet), high linoleic acid safflower oil (SO, 200 g/d) or no dietary supplements (control, CON) in a 4 × 4 Latin square. The basal diet comprised (DM basis) 80% barley grain, 18% barley silage, 1% canola meal and 1% mineral, and was consumed ad libitum. All antiprotozoal agents (APA) tended ($P = 0.1$) to reduce total protozoal numbers, relative to CON, and all reduced ($P < 0.05$) *Entodinium* populations ($\log_{10}$/mL ruminal fluid), as compared with CON; in CON, QT, QE and SO, these were 6.2, 5.7, 5.9 and 5.8, respectively. Populations of *Epidinium*, *Isotricha*, *Dasytricha*, *Diplodinium* and *Ophryoscolex* spp. were lower ($P < 0.001$) with SO than with the other APA. With CON, QE, QT and SO diets, respectively, 2.0, 11.4, 5.7 and 0.2% of protozoa were cellulolytic. Treatment did not affect ($P > 0.05$) mean ruminal pH or concentrations of reducing sugars, ammonia, total free amino acids, soluble protein, peptides, total VFA or individual VFA except isobutyrate, for which CON and SO > QE > QT ($P < 0.05$). Isobutyrate was present at 1.28, 1.26, 1.19 and 1.08 mM with CON, SO, QE and QT, respectively. Feeding QE or SO reduced ($P < 0.05$) ruminal carboxymethylcellulase activity, compared to CON. Treatment did not affect ($P > 0.05$) nutrient intake or digestibility, duodenal nitrogen (N) flow or urea and glucose in blood. Urinary N excretion (as % of N intake) was lower ($P < 0.05$) with QT (57.7%) than with CON (66.3%), QE (65%) or SO (66.7%). All three compounds studied reduced *Entodinium* populations, which as a group have the largest negative impact on bacterial turnover in the rumen, with no adverse effects on fermentation or nutrient digestion. Thus, each may have potential for use as a selective agent for reducing the impact of *Entodinium* on bacterial N recycling in cattle.

Key Words: Rumen Protozoa, N Recycling, Cattle

1622 Characterization of microbial adaptation in dairy cows with changes in diet and lactational state. A.F. Park*, J.E. Shirley, E.C. Titgemeyer, R.C. Cochran, J.M. DeFrain, E.E. Ferdinand, N Wallace, and T.G. Nagaraja, [1]*Kansas State University, Manhattan Kansas.*

Four-ruminally fistulated, multiparous, pregnant Holstein cows were utilized in a randomized design to delineate microbial adaptations as the cow transitioned from a non-lactational to lactational state. Microbial measurements were obtained 51 (far-off dry), 23, and 9 d (close-up dry) prepartum and 6, 20, 34, 48, 62, 76, and 90 d postpartum. Calculated NEL (Mcal/kg), measured crude protein (%) and digestibilities (based on steers fed the same diets at 2% of BW) of the diets were 1.46, 11.5, 66.2; 1.56, 15.6, 71.0; 1.70, 18.4, 70.7 for far-off dry, close-up dry, and early lactation. Counts of protozoa and viable counts of bacteria and fungi were assessed using the most probable number technique. Total and cellulolytic fungi decreased (3.2×10^6 versus 10 counts) when cows were switched from the far-off to the close up diet then increased (10 versus 3.2×10^4 counts) prior to calving. Total fungi increased and remained relatively constant (3.2×10^6) after parturition but total cellulolytic fungi approached zero on d 6 postpartum, then increased to 3.2×10^4 on d 20, remaining fairly constant thereafter. The population of cellulolytic bacteria was relatively constant across diets (1.5×10^9) but total bacteria decreased during the dry period (1.0×10^{13} versus 1.0×10^{10}) then remained relatively stable (3.2×10^{11}) during the first 90 d of lactation. Total protozoa (1.6×10^{10}) were unaffected by diet and lactational state. These data illustrate rumen microbial adaptations to changes in diet and lactational state.

Key Words: Periparturient, Dairy cow, Microbial

1623 The effect of buffers on rumen fermentation patterns. A Jackson[1], J Spain[2], J Sampson*[2], D Chatman[2], and M Ellerseick[2], [1]*University of Arkansas-Pine Bluff,* [2]*University of Missouri-Columbia.*

This study was conducted to measure the effects of presence and source of supplemental buffer on rumen pH and fermentation. A single effluent continuous culture system was used to model rumen fermentation. Rumen fluid for the fermenters was obtained from two, ruminally fistulated lactating Holsteins and commingled. Rumen fluid was collected by squeezing fluid from whole rumen contents through commercially available cheesecloth. Fermenters were fed a diet typically fed to cows during the final phase before calving. Fermenters received this moderate NFC diet for 4 days. On days 5-7, the fermenters were fed a high energy, low fiber diet typically fed to lactating cows. The control diet (A) contained no buffer. Diet B contained a standard feed grade buffer included in the diet at 0.75% of the lactation diet DM. Diet C contained a 1:1 ratio of feed grade buffer to encapsulated sodium bicarbonate buffer at 0.75% of the lactation diet DM. Diet D contained encapsulated buffer at 0.75% of the lactation diet DM. The fermenters were fed at 700, 1500 and 2300 h. The pH of each fermenter was measured four times daily at 0, 2, 4 and 6 hours following the 7 a.m. feeding. Samples were taken daily from each fermenter to measure ammonia levels. Fermenter pH levels increased when buffers were added to the diet. Diet D maintained fermenter pH that was significantly higher than the other diets. Diet D also maintained higher pH in the fermenters across all three days fermenters were fed the high-energy diet. Diet D also maintained the highest pH for hours 0, 2, 4 and 6. Ammonia levels were not different due to dietary treatment. Ammonia levels increased significantly (P=0.019) from days 5-7 as the microbes adapted to the diet containing the higher concentration of dietary crude protein. These data provide evidence that encapsulated buffers provided a sustained release of sodium bicarbonate that minimized the acidic conditions in the rumen associated with feeding low-fiber diets.

Key Words: Rumen pH, Rumen Fermentation, Rumen Buffers

1624 Effects of level of pelleted beet pulp substituted for high-moisture corn on rumen digestion kinetics and microbial protein efficiency in lactating dairy cows. J. A. Voelker* and M. S. Allen, *Michigan State University.*

Effects of increasing levels of pelleted beet pulp substituted for high-moisture corn were evaluated with 8 ruminally and duodenally cannulated multiparous Holstein cows in a duplicated 4x4 Latin square design with 21-d periods. Cows were 79 ± 17 (mean ± SD) DIM at the beginning of the experiment. Experimental diets with 40% forage (corn silage and alfalfa silage) and 60% concentrate contained 0%, 6.1%, 12.1%, or 24.3% beet pulp (0BP, 6BP, 12BP, and 24BP, respectively) substituted for high-moisture corn on a DM basis. Diet contents of NDF and starch were 24.3% and 35.4% (0BP), 26.2% and 31.2% (6BP), 28.0% and 27.0% (12BP), and 31.6% and 18.6% (24BP), respectively. True rumen digestibility of starch decreased with increasing BP substitution ($P < 0.01$). This was caused by a linear increase in starch passage rate ($P < 0.05$), and a linear decrease in digestion rate ($P < 0.01$) of starch in the rumen, possibly the result of reduced amylolytic enzyme activity of rumen fluid. Although substituting BP for corn decreased rumen starch digestibility, true rumen OM digestibility and microbial N flow to the duodenum were not affected by treatment ($P > 0.20$), nor was microbial nitrogen efficiency (MNE), expressed as microbial N flow to the duodenum as a percent of OM truly digested in the rumen ($P > 0.20$). MNE was not correlated to mean rumen pH ($P > 0.40$) or daily minimum pH ($P > 0.60$). MNE was positively correlated with passage rates of starch ($r = 0.66$, $P < 0.001$) and indigestible NDF ($r = 0.64$, $P < 0.001$), which were increased by substituting BP for corn ($P < 0.05$). Increasing passage rate probably increases MNE by increasing the rate at which microbes escaped lysis and predation in the rumen. Although substituting BP for high-moisture corn might have increased rate of microbial passage from the rumen relative to lysis, rumen microbial pool might have been reduced by lower starch fermentation, resulting in no overall effect on MNE.

Key Words: Beet pulp, High-moisture corn, Rumen microbial N efficiency

1625 Effects of NPN in alfalfa and red clover silages on production of lactating cows. JJ Olmos Colmenero*[1], AF Brito[1], GA Broderick, and SM Reynal, [1]*University of Wisconsin-Madison,* [2]*US Dairy Forage Research Center.*

Sixteen multiparous and 8 primiparous Holstein cows (8 ruminally fistulated) were randomly assigned to six 4 x 4 Latin squares to assess the effect of NPN level in alfalfa and red clover silages on milk production, ruminal metabolites, microbial protein synthesis, and ruminal escape of amino acids and peptides. The experimental diets contained (DM basis): 50% control alfalfa silage (AS), 50% formic acid-treated alfalfa silage (AAS), 50% red clover silage (RCS1, lower NDF and CP than AS), or 50% red clover silage (RCS2, similar to AS in NDF and CP). Diets were formulated to contain about 17% CP and NDF content was 28, 29, 27 and 29%, respectively, for diets AS, AAS, RCS1 and RCS2. DMI and milk yield were higher for AS and AAS compared to RCS2, whereas RCS1 was intermediate. Fat and protein yield, MUN and rumen ammonia were higher for the alfalfa silages relative to both red clover silages. Apparent digestibilities of DM and NDF were highest on RCS2, intermediate on RCS1 and lowest on the alfalfa silages. Rumen pH, acetate, propionate and acetate:propionate ratio did not differ. RCS1 had higher N efficiency than the alfalfa silages while RCS2 was intermediate. Overall, feeding alfalfa silages resulted in greater DMI and milk yield than feeding red clover silages; however, N utilization, BW gain, and nutrient digestibilities were greater in cows fed red clover silages.

Item	AS	AAS	RCS1	RCS2	SELSMD[1]
DMI, kg/d	23.3^{ab}	23.7^{a}	22.2^{bc}	21.5^{c}	0.7
BW gain, kg/d	0.19^{bc}	0.09^{c}	0.66^{a}	0.62^{ab}	0.25
Milk yield, kg/d	30.5^{a}	30.8^{a}	29.5^{ab}	28.6^{b}	0.8
Milk fat, kg/d	1.23^{a}	1.25^{a}	1.14^{b}	1.10^{b}	0.04
Milk protein, kg/d	0.99^{a}	1.02^{a}	0.94^{b}	0.90^{b}	0.03
MUN, mg/dl	19.1^{a}	18.1^{a}	15.3^{b}	14.9^{b}	0.8
Milk-N/N-intake, %	22.3^{b}	22.4^{b}	24.6^{a}	23.2^{ab}	1.0
DM digestibility, %	58.7^{c}	57.4^{c}	60.7^{b}	63.9^{a}	1.1
NDF digestibility, %	37.2^{a}	36.9^{c}	48.2^{b}	55.0^{a}	1.2
Rumen pH	6.38	6.41	6.45	6.45	0.05
Rumen amonia, mM	10.0^{a}	9.1^{a}	4.7^{b}	5.7^{b}	0.7
Rumen TAA, mM	4.0^{a}	3.4^{ab}	2.3^{c}	2.9^{bc}	0.4
Rumen Acetate, mM	74.4	73.8	75.8	73.5	2.3
Rumen Propionate, mM	21.2	21.1	21.9	21.15	0.9
Rumen Ace:Prop	3.56	3.57	3.55	3.54	0.09

[1]Standard error of least square mean difference; ^{a,b,c}Means in rows without common superscripts are diffrent (P<0.05)

Key Words: NPN, Red clover silage, Alfalfa silage

Sheep Species

1626 Assessment of gestational age in Chall ewes by ultrasonography. Sarang Soroori[1], Parviz Tajik[2], and Abbas Veshkini, [1]*Ferdowsi University of Mashhad, Faculty of Veterinary Medicine,Mashhad,Tehran,* [2]*University of Tehran, Faculty of Veterinary Medicine, Tehran, Iran.*

To assess gestational age by ultrasonography,16 synchronized estrous Iranian Chall ewes were placed with fertile rams from the same breed. After mating these ewes were separated from the rams and ultrasonograghy program was performed. In order to assess the earliest time of pregnancy,ultrasonography was performed daily from the day 10 to 26 of mating,and two times a week from day 26 to 68,and once a week from day 68 until parturition for all ewes.Ultrasonography diagnosis was performed using intrarectal technique as well as transcutaneous.The earliest assessment of pregnancy was day 18 in which pregnancy could be diagnosed in two ewes.The best criterion pregnancy diagnosis in primary days of pregnancy was observation of embryonic vesicle by intrarectal ultrasonograghy.By increasing of gestational age some criteria such as Thoracic Depth(Dorsoventral diameter of thoracic cavity),Abdominal Depth(Dorsoventral diameter of abdominal cavity)and Intercostal Space were measured. Regarding to the results of the present study some morphometric values were gained by which the gestational age could be assessed in this breed.

Key Words: Ultrasonography, Pregnancy, Ewe

1627 The effects of offering grass or maize silages with mineral lick supplementation to pregnant ewes on ewe performance and IgG absorption in the lamb. T.F. Crosby*[1], J.V. O'Doherty[1], P. Nowakowski[2], P.J. Quinn[1], J.J. Callan[1], B. Flynn[1], D. Cunningham[1], P. Reilly[1], and D. Joyce[1], [1]*University College Dublin, Faculty of Agriculture, Belfield, Dublin 4, IRELAND,* [2]*Agricultural University Wroclaw, Department of Sheep Breeding, Wroclaw, POLAND.*

Individually fed twin bearing ewes (n=64) were offered either grass or maize silage ad-libitum which was supplemented with 400g concentrates per day in addition to they having limited access (3-5h/d) to a molasses based mineral lick (ML) from day 92 of pregnancy until lambing, in order to evaluate the effects of the mineral lick supplementation on ewe performance and immunoglobulin (IgG) absorption in the lamb. Average daily ML intake was 84.3g and 93.7g for the grass and maize silages respectively. Forage DM intake was higher for the maize than for grass silage (1.11 vs 0.95 kg/ewe; SEM 0.037; P<0.05) and also when ewes had access to ML (1.10 vs 0.96 kg/ewe; SEM 0.037; P<0.01). A similar trend applied to protein intake. There was a big increase in daily water intake when ewes had access to ML (3.7 vs 2.69 l/day; SEM 0.101; P<0.01). The ML treatment had no effect on ewe live weight change, body condition score change, gestation length, litter weight or the incidence of mal-presentations at lambing (P>0.05). When ewes had access to ML, colostrum yield tended to be higher at the 1h milking (598 vs 436 g/ewe; SEM 60.6; P=0.06) but there was no effect on the concentration of solids, crude protein or colostral IgG concentration (P>0.05). In contrast, lambs fed colostrum obtained from ewes on the ML treatment had significantly lower serum IgG concentration (6.8 vs 18.8 g/litre; SEM 1.48; P< 0.05) and the percentage of IgG absorbed from the colostrum was also lower (9.71 vs 24.74; SEM 2.140; P<0.01) These data clearly show that when pregnant ewes have access to molasses based mineral licks in late pregnancy that water intake is considerably increased and the lamb has a dangerously lowered level of protective antibodies in the serum, so necessary to protect it from disease. Further research is needed to determine if the lowered IgG absorption is due to programming of the foetus in utero or is due to changed characteristics of the colostrum.

Key Words: Sheep, Colostrum, Immunoglobulin

1628 Performance of St. Croix White and Dorper x St. Croix White lambs from birth to weaning in the tropics. R.W. Godfrey*, A.J. Weis, and R.E. Dodson, *Agricultural Experiment Station, University of the Virgin Islands.*

To evaluate the neonatal and pre-weaning performance of crossbred lambs under tropical conditions a Dorper (DRP) and a St. Croix White (STX) ram were bred to STX ewes (n = 12 and 14 ewes/sire, respectively). Ewes were maintained on guinea grass pastures (.4 ha) in a rotational grazing system from the start of breeding (June) through weaning (August/September). The 24-hr milk production of all ewes was measured on days 7, 21, 35, 49 and 63 (lambing = d 0). Ewes were given 1 IU of oxytocin (i.v.) and milked by hand and separated from their lambs. Four hours later ewes were hand milked, using oxytocin, and the milk was weighed to determine 24-h milk production. Total milk production was determined as the sum of 24-h milk production for each day of milking. Ewes were weighed weekly. Lambs were weighed at birth and at weaning at 63 d of age. Data were analyzed using GLM procedures of SAS. Dorper-sired lambs were heavier at birth (P< 0.008) than STX-sired lambs (3.4 ± 0.1 vs 2.9 ± 0.1 kg, respectively). Lamb survival rate at birth, 1 wk of age or weaning was not different (P > 0.10) between DRP and STX sire groups (100, 95.2 and 85.7 vs 100, 88.5 and 84.6 %, respectively). Ewe body weight at lambing was not different (P > 0.10) between DRP and STX sire groups (41.1 ± 1.5 vs 41.1 ± 1.3 kg, respectively). Weaning weight of DRP lambs was greater (P< 0.008) than STX lambs (14.7 ± 0.4 vs 13.2 ± 0.4 kg, respectively). Ewe weight at weaning was not different (P> 0.10) between DRP and STX sire groups (42.8 ± 1.6 vs 44.3 ± 1.6 kg, respectively). Milk production of ewes during the 63-d lactation was not different (P > 0.10) between sire groups. There was no difference (P > 0.10) in total milk production between DRP and STX bred ewes (4577 ± 324 vs 4507 ±