

ASAS/ADSA Ruminant Nutrition: By-Products, Fiber, and Silages

1712 Effect of feeding dairy cows with either BollGard[®], BollGard[®] II, Roundup Ready[®] or control cottonseeds on feed intake, milk yield and milk composition. A.R. Castillo^{*1}, M.R. Gallardo¹, M. Maciel¹, J.M. Giordano¹, G.A. Conti¹, M.C. Gaggiotti¹, O. Quaino¹, C. Gianni², and G.F. Hartnell², ¹Experimental Station Rafaela INTA, Argentina, ²Monsanto Co., St. Louis, MO.

This experiment evaluated the effect of feeding dairy cows with cottonseeds containing BollGard[®] (Cry1Ac) and BollGard[®] II (Cry1Ac and Cry2Ab), Roundup Ready[®] (CP4 EPSPS) and control non-transgenic cottonseed on dry matter intake, milk yield and milk composition. Twelve lactating multiparous Argentinean Holstein cows weighing 570 kg (BW) were used in a 4x4 Latin square design, with 3 squares each containing 4 cows, four 4-week periods and four treatments. The treatments were control cottonseed non-genetically modified (DP50), BollGard[®] (DP50B) that contains the Cry1Ac gene, BollGard[®] II (DP50BII) that contain both Cry1Ac and Cry2Ab genes and Roundup Ready[®] (DP50RR) that contain the CP4 EPSPS gene. All the cows received the same diet of corn silage, alfalfa hay, ground corn, soybean meal, minerals, vitamins. The individual cottonseeds were hand mixed in with the diet. There were no significant differences ($P>0.05$) in total dry matter intake (DMI) or cottonseed intakes, averaging 23.7 and 2.3 kgDM/cow/d respectively. Milk yield, milk composition (fat, protein, lactose, non-fat solids and urea) and body condition score (BCS) were comparable ($P<0.05$) among the treatments. Results of this study indicate that cottonseed of genetically modified varieties (BollGard[®], BollGard[®] II and Roundup Ready[®]) shown similar performance as control cottonseed.

| Parameter | DP50 | DP50B | DP50BII | DP50RR | se | P< |
|---------------------|-------|-------|---------|--------|--------|-------|
| DMI, kg/d | 23.38 | 23.78 | 23.93 | 23.75 | 0.337 | 0.699 |
| Cottonseed, kg/d | 2.25 | 2.29 | 2.28 | 2.27 | 0.038 | 0.871 |
| Milk yield, kg/d | 26.87 | 26.71 | 27.56 | 27.42 | 0.622 | 0.724 |
| Milk composition, % | | | | | | |
| Fat | 3.58 | 3.60 | 3.52 | 3.53 | 0.094 | 0.807 |
| Protein | 3.15 | 3.14 | 3.14 | 3.13 | 0.026 | 0.953 |
| Lactose | 4.97 | 5.01 | 5.04 | 5.00 | 0.024 | 0.166 |
| Non-fat solids | 8.84 | 8.91 | 8.96 | 8.90 | 0.043 | 0.341 |
| Urea | 0.040 | 0.042 | 0.044 | 0.043 | 0.0013 | 0.185 |
| BCS | 2.30 | 2.30 | 2.30 | 2.34 | 0.026 | 0.621 |

Key Words: Genetically modified cottonseeds, Milk production, Dry matter intake

1713 Effect of feeding dairy cows with cottonseeds containing Bollgard[®] and Roundup Ready[®] genes or control non-transgenic cottonseeds on feed intake, milk yield and milk composition. A.R. Castillo^{*1}, M.R. Gallardo¹, M. Maciel¹, J.M. Giordano¹, G.A. Conti¹, M.C. Gaggiotti¹, O. Quaino¹, C. Gianni², and G.F. Hartnell², ¹Experimental Station Rafaela, INTA, Argentina, ²Monsanto Co., St. Louis, MO.

The purpose of the experiment was to evaluate the effect of feeding dairy cows with cottonseed containing BollGard[®] (Cry1Ac) and Roundup Ready[®] (CP4 EPSPS) and control non-transgenic cottonseeds on feed intake, milk yield and milk composition. Twelve lactating multiparous Argentinean Holstein cows weighing 570 kg (BW) were used in a 4x4 Latin square design, with 3 squares each containing 4 cows, four 4-week periods and four treatments. The treatments were three non-transgenic cottonseeds from two commercial sources (Guazucho and Pora), a parental line (Chaco520) and the genetically modified cottonseed (Chaco520BGRR). All the cows received the same diet of corn silage, alfalfa hay, ground corn, soybean meal, minerals and vitamins. The individual cottonseeds were hand mixed in with the diet. There were no significant differences ($P>0.05$) in total dry matter intake (DMI) or cottonseed intakes, averaging 22.9 and 2.3 kgDM/cow/d respectively. Milk yield, milk composition (fat, protein, lactose, non-fat solids and urea) and body condition score (BCS) were comparable ($P<0.05$) among the treatments. Results of this study indicate that cottonseed of genetically modified variety (BollGard[®] and Roundup Ready[®]) shown similar performance as control cottonseeds.

| Parameter | Guazucho | Pora | Chaco | | sed | P< |
|---------------------|----------|-------|-------|---------|--------|-------|
| | | | 520 | 520BGRR | | |
| DMI, kg/d | 22.87 | 23.03 | 22.99 | 22.36 | 0.435 | 0.405 |
| Cottonseed, kg/d | 2.28 | 2.29 | 2.30 | 2.23 | 0.041 | 0.331 |
| Milk yield, kg/d | 26.79 | 27.42 | 27.47 | 26.48 | 0.878 | 0.637 |
| Milk Composition, % | | | | | | |
| Fat | 3.36 | 3.26 | 3.32 | 3.35 | 0.099 | 0.775 |
| Protein | 3.15 | 3.09 | 3.32 | 3.35 | 0.052 | 0.550 |
| Lactose | 4.86 | 4.85 | 4.83 | 4.83 | 0.044 | 0.879 |
| Non-fat solids | 8.73 | 8.69 | 8.72 | 8.77 | 0.055 | 0.518 |
| Urea | 0.034 | 0.036 | 0.036 | 0.031 | 0.0022 | 0.117 |
| BCS | 2.31 | 2.36 | 2.33 | 2.25 | 0.056 | 0.265 |

Key Words: Genetically modified cottonseeds, Milk production, Dry matter intake

1714 Effect of chopped and ground roughage on ruminal parameters and voluntary feed intake of sheep. H. G. Gonzalez^{*1,3}, O. B. Ruiz², L. C. De la Vega², E. T. Rubio¹, O. R. Barrozo¹, N. E. Bujanda¹, N. A. Loya¹, E. S. Garcia¹, I. G. Ramos¹, and H. C. Hernandez⁴, ¹Medicina Veterinaria y Zootecnia-ICB, Universidad Autonoma de Ciudad Juarez, ²Universidad Autonoma de Chihuahua, ³Universidad Autonoma de Baja California, ⁴Universidad Autonoma de Baja California Sur.

Eight crossbred sheep (36 kg) with permanent rumen cannulas were used to evaluate if two different chop length: 2.5 cm (T1) and 10 cm (T2) of forage could affect ruminal parameters and voluntary feed intake. The animals were fed *ad libitum* with diets consisting of oat straw plus an alfalfa hay supplement (20 % of the diet). The supplement was offered once daily at 0800 h. Rumen fluid samples were collected of each animal at 0, 1.5, 3, 6, 9, 12, 16, and 24 h after meal and analyzed for pH, ammonia-nitrogen (NH₃-N) and volatile fatty acid (VFA) concentration. The analysis of data was using a crossover design. There were no differences ($P>.05$) in DMI (57.82 vs 58 g kg⁻¹W^{.75}), pH (6.85 vs 6.93), NH₃-N(12.33 vs 12.27 mg 100ml⁻¹), propionic (14.87 vs 14.01 mM), butyric (5.64 vs 5.76 mM), and isobutyric (0.77 vs 0.77 mM) acids for T1 and T2, respectively. However, a significant difference was detected ($P<.08$) between T1 and T2 in concentration of acetic acid (78.22 vs 79.18 mM). The size of forage particle did not affect the DMI and ruminal parameters in sheep.

Key Words: Sheep, Ruminal parameters, Intake

1715 A comparison of methods used to measure eating and ruminating time in cattle. H. A. Lehman, P. J. Kononoff, and A. J. Heinrichs, *The Pennsylvania State University*.

Detailed knowledge of chewing and rumination activities are critical in order to fully understand the dietary factors affecting normal rumen function. An automatic system for the digital recording of the jaw movements in free-ranging grazing cattle has been described but its ability to measure chewing activity of cattle housed in confinement and fed total mixed rations has not yet been evaluated. The eating and ruminating behaviors of eight lactating dairy cows were recorded simultaneously by a wireless automatic system and by observation over 24 h periods. Data recorded by the automatic system were processed to identify periods of eating and ruminating in each of the cows. Mean total time eating and ruminating as measured by each method were compared using a paired sample t test. Results indicated both methods agreed on identification of eating and ruminating activities 99.1 % and 97.7%, respectively. Mean differences between methods for total time eating (31.0 min + 23.14) and ruminating (54.8 min + 19.13) were significantly different. The time recorded by observation in both eating and rumination was approximately 15% higher when compared to the automatic system. Disagreement between methods most likely indicates inaccuracies in the observational method itself. When different methods of measurements are used to approximate biological parameters such as salivary buffer flow or the amount of energy expended on chewing activity, overestimation was consistent when the observational method was employed. The

automatic system may prove useful in further studies examining eating and rumination activities in cattle.

Key Words: ruminating behavior, eating behavior, Graze software

1716 Effect of two particle sizes of forage on ruminal parameters and voluntary feed intake of steers fed a basal oat straw diet. H. G. Gonzalez^{1,3}, O. B. Ruiz², L. C. De la Vega², E. T. Rubio¹, O. R. Barrozo¹, N. E. Bujanda¹, N. A. Loya¹, I. G. Ramos¹, E. S. Garcia¹, and H. C. Hernandez⁴, ¹Medicina Veterinaria y Zootecnia-ICB, Universidad Autonoma de Ciudad Juarez, Mexico, ²Universidad Autonoma de Chihuahua, ³Universidad Autonoma de Baja California, ⁴Universidad Autonoma de Baja California Sur.

Four Hereford steers (300 kg) with permanent rumen cannulas were used to evaluate two chop lengths: 2.5 cm (T1) and 10 cm (T2) of forage on ruminal parameters and voluntary feed intake. The animals were fed *ad libitum* with a basal oat straw diet plus an alfalfa hay supplement (20 % of the diet). Alfalfa was offered once daily at 0800 h. Rumen fluid samples were collected from each animal at 0, 1.5, 3, 6, 9, 12, 16, and 24 h after meal and analyzed for pH, ammonia-nitrogen (NH₃-N) and volatile fatty acids (VFA) concentration. The analysis of data used a switch back design. A higher DMI was observed ($P < .09$) in T1 compared to T2 (78.64 vs 72.07 g kg⁻¹W^{.75}). No differences ($P > .05$) were found in pH (7.82 vs 7.56), NH₃-N (6.81 vs 6.91 mg 100ml⁻¹), and propionic acid (15.36 vs 14.98 mM) for T1 and T2, respectively. However there were significant differences ($P < .01$) between T1 and T2 in concentration of butyric (6.51 vs 4.89 mM), isobutyric (0.74 vs 0.4 mM), and acetic ($P < .07$; 77.39 vs 79.72 mM). The size of forage particle affected the VFA concentration and DMI.

Key Words: Steers, Ruminal parameters, Intake

1717 Feed Intake, Digestibility, and Growth of Spanish Goats Consuming Different Quality Diets. T. Wuliji, A.L. Goetsch, R. Puchala, S. Soto-Navarro*, R.C. Merkel, G. Detweiler, T.A. Gipson, and T. Sahl, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Fifty-two Spanish kids (average initial BW = 13.5 ± 0.06 kg) were used in an experiment with two 9-wk phases. Three diets were used: prairie hay consumed *ad libitum* and supplemented with 0.125% BW (DM) of soybean meal (average = 21.4 g/d; H), dehydrated alfalfa pellets consumed *ad libitum* (A); and a 70% concentrate diet consumed *ad libitum* (C). Treatments were A in Phases 1 and 2 (AA), C in Phases 1 and 2 (CC), H in Phase 1 and A in Phase 2 (HA), H in Phase 1 and C in Phase 2 (HC), and A in Phase 1 and C in Phase 2 (AC). Dry matter intake in Phase 1 was lowest ($P < 0.05$) for HA and HC and greater ($P < 0.05$) for AA and AC than for CC (636, 502, 385, 352 and 634 g/d), and DMI in Phase 2 was 839, 629, 834, 636 and 805 g/d (SE = 12.6) for AA, CC, HA, HC, and AC, respectively. Average daily gain for AA, CC, HA, HC, and AC, respectively, was 81, 79, 0, 0 and 86 g (SE = 17.6) in Phase 1 and 73, 54, 112, 82, and 92 g (SE = 29.9) in Phase 2. Apparent total tract DM digestibility, determined at the end of the performance period with five animals per diet, ranked ($P < 0.05$) H < A < C (39, 54, and 66%, respectively). Likewise, ruminal pH was greatest for C and lowest for H ($P < 0.05$; 6.0, 6.5, and 6.8 for H, A, and C, respectively). The concentration of total VFA in ruminal fluid at 4 h after feeding was 35, 104, and 68 mmol/L for H, A, and C, respectively (SE = 3). In conclusion, dehydrated alfalfa pellets supported performance of Spanish kids as great or greater than that with a concentrate-based diet, when fed continuously and following consumption of a low-quality forage-based diet.

Key Words: Goats, Growth, Diet Quality

1718 Methane loss, nutrient digestibility, and net energy value of distiller's grains fed to steers or fermented *in vitro*. M. J. Jarosz*¹ and D. E. Johnson², ¹Purina Mills, St. Louis, MO, ²Colorado State University.

The nutrient digestibility, methane production, and net energy value of dried distiller's grains (DG) was measured with steers by concomitant 2-d respiration calorimetry and 7-d balance trial. Effects of the concentration of DG, dried brewer's grains (BG) or oil on methane production were determined by *in vitro* gas pressure technique. Six steers were fed

a 60% concentrate basal diet with 0, 20, or 40% DG and energy partitioning measured in a 3 x 3 Latin square design. Four *in vitro* trials evaluated 0, 20, 40, 60, 80, and 100% BG or DG replacing alfalfa, 0, 2, 4, 6, 8, and 10% corn oil replacing corn gluten feed (CGF), and normal and non-lipid BG and DG. Inclusion of DG in the diet fed to steers did not significantly decrease methane production (5.9%, versus 6.2% of GE for control diet). Successive DG additions to the alfalfa substrate, *in vitro*, first increased and then decreased methane production to 19% below control when 100% DG was fermented (cubic effect, $P < 0.01$). Methane production was also first increased and then decreased (quadratic, $P < 0.01$) when BG was successively added *in vitro*, reducing methane to 62% of control at 100% BG. *In vitro* additions of corn oil to corn gluten feed linearly ($P < 0.01$) decreased methane production over concentrations ranging from 0 to 10%, while removal of lipid from BG or DG did not alter methane production. When fed to steers, the distiller's grains additions of 20 and 40% did not significantly change DM digestibility, however, NDF digestibility increased ($P < 0.05$) by 17 and 30%, and %DE increased by 2 (N.S.) and 8% when compared to the control diet. Similarly, ME (Mcal/kg DM) content of the DG diets was 7% greater ($P < 0.05$) for each 20 percentage unit addition of DG to the diet. The heat production by the steers did not change with diet resulting in slightly greater (N.S.) partial efficiencies of ME use for maintenance and gain and a 10 and 19% improvement in NEm and NEg content of the 20 and 40% DG diets above control. Calculated by difference using the respiration calorimetry technique, the energy value of DG is; ME, 3.88, NEm, 2.92, and NEg, 2.42 Mcal/kg DM. Applying the slaughter balance derived conversion from ME to NE (NRC, 1996) provides estimates of 2.73 Mcal NEm and 1.95 Mcal NEg/kg DM, 25 to 30% above current tabular values.

Key Words: Distiller's grains, Methane, Net energy

1719 The effect of feeding a novel silage, consisting of liquid cheese whey and wheat straw, on production and digestibility characteristics of growing dairy heifers and beef steers. D.R. ZoBell*, K.C. Olson, R.D. Wiedmeier, and C.A. Stonecipher, *Utah State University, Logan, UT.*

A novel whey silage (WS) was produced in bunker silos at two separate locations. Liquid cheese whey (50% DM) was combined with wheat straw and wheat middlings at proportions of 63.1%, 28.9% and 8.0% (DMB) respectively. Nutrient and fermentation analysis of the WS (30d ensiling period) indicated approx. 44.8% DM, 14.3% CP, 1.87 Mcal/kg NEm, 1.23 Mcal/kg NEg, 4.3 pH, 10.5% lactic acid and 11.2% Total VFA (DMB). At location 1, 60 weaned beef steers were assigned either Control (C), Treatment 1 (T1) or Treatment 2 (T2). There were 5 steers per pen and 4 pens per treatment for this 56d trial. The C steers received 19.0% alfalfa hay (AH), 32.4% corn silage (CS), 39.9% rolled barley (RB), 5.6% SBM and 3.1% supplement and T1 and T2 steers 24.8% CS, 31.0% WS, 35.7% RB, 5.2% SBM and 3.3% supp or 65.5% WS, 31.3% RB and 3.2% supp respectively. All rations were isocaloric and isonitrogenous. Overall ADG (kg), DMI (kg) and FE for C, T1 and T2 steers were 1.18, 1.25, and 1.34 ($P = .09$); 7.09, 8.68 and 9.36 ($P = .0001$); 6.04, 7.01 and 7.07 ($P = .02$) respectively. *In vivo* DM and NDF digestibilities were similar when comparing C and T2 diets ($P > .05$). At location 2, 48 growing holstein heifers were assigned C or T diets with 8 heifers per pen and 3 pens per treatment for 56d. Control heifers received 16.8% AH, 46.2% CS, 36.9% wheat middlings and .1% supp. and T heifers 98.3% WS and 1.7% supp. The C and T rations were isocaloric and isonitrogenous. Overall ADG (kg), DMI (kg) and FE for C and T heifers were 1.14 and 1.07 ($P = .05$), 7.47 and 5.91 ($P = .001$) and 6.55 and 5.57 ($P = .028$) respectively. *In vitro* DM digestibility was improved with treatment ($P < .05$). Whey silage can be produced successfully and can increase production characteristics of growing holstein heifers but may not in growing beef steers.

Key Words: cheese whey, silage, growing steers and holstein heifers

1720 Selected fractionate digestibility coefficients of wheat middling and soybean hull mixtures amended with human food waste. P.M. Walker*, J.M. Dust, D.M. Finnigan, and S.B. Brown, *Illinois State University, Normal, IL USA.*

Suffolk wethers 6 - 7 months old and weighing 44.6 ± 4.8kg were used in two trials (T1 and T2) to determine the apparent digestible energy and digestibility coefficients of dietary DM, CP, ADF and ether extract (EE) of a dehydrated wheat middling (WM) and food waste mixture (DF) and

an extruded soybean hull (SBH) and food waste mixture (EF). In T1 WM and ground food waste originating from retail groceries were mixed in a 75: 25 ratio (DM basis), passed through a grinder/pelletizer and dehydrated. In T2 pulped plate waste (PW) obtained from university dining centers was mixed and extruded in a 40: 60 ratio (wet wt. basis) with an extruded combination of PW: SBH: rolled corn (40: 55: 5), on a wet wt. basis to provide a mixture containing 40.4% PW on a DM basis. In T1 and T2 28 lambs were randomly allotted to metabolism crates and were fed the extruded feed mixtures at 3.6% and 3.8% of body wt, respectively, for 30d with total fecal collection the last 7d. Gross energy was determined on all samples with an adiabatic bomb calorimeter. DF was found to contain 92.7 ± .4% DM, 20.9 ± 3.0% CP, 7.9 ± .6 ether extract (EE) and 11.2 ± .7% ADF. Apparent digestible energy of DF was determined to be 3.17 ± .24 Mcal/kg. DF apparent digestibility coefficients were 65.0 ± 4.8% DM, 75.0 ± 4.9% protein, 15.7 ± 10.8% ADF and 79.4 ± 5.1 EE. EF was found to contain 93.9 ± .9% DM, 17.7 ± 4.4% CP, 4.8 ± .7% EE and 32.2 ± 2.3% ADF. Apparent digestible energy of EF was determined to be 2.66 ± .18 Mcal/kg. EF apparent digestibility coefficients were 58.2 ± 4.2% DM, 62.5 ± 7.3% CP, 27.2 ± 7.8% ADF and 79.8 ± 6.7% EE. This study suggests amending WM and SBH with food waste is an acceptable method for including human food waste in livestock diets.

Key Words: Food Waste, Digestibility Coefficients

1721 Effects of feeding wheat middlings on performance of dairy cows in early lactation. G.D. Marx*, *University of Minnesota, Crookston, MN.*

Forty early lactation primiparous and multiparous Holstein cows were equally assigned to either a diet containing 10% wheat middlings (WM) or a control diet containing corn and soybean meal (CS) at equal ration DM content. The objective of the study was to determine the value of wheat middlings, an economic opportunity feed, using high producing cows. Performance of cows was determined on the two diets during a 12-wk study preceded by a 2-wk standardizing period. Total mixed rations were fed once daily to each group with the balance of the ration consisting of alfalfa haylage, corn silage, high-moisture corn, soybean meal, vitamins and minerals to meet NRC requirements for high producing cows. Cows were kept in individual tie stalls and fed to appetite plus 2.3 kg adjusted daily according to intake. Daily DMI and weigh-backs were measured on each individual cow. General linear models of SAS were utilized to determine statistical significance of the data. Daily milk production, milk fat and milk protein for cows fed WM were 36.9, 1.31 and 1.17 kg and cows fed CS were 38.0, 1.23 and 1.19 kg. Milk production and these milk components did not differ ($P>0.05$) between groups. Peak milk production was similar on each treatment. Average daily DMI did not differ between treatments and were 21.92 and 21.67 kg for the WM and CS fed cows. Average body condition scores were similar for both the WM and CS groups with scores of 3.18 and 3.12. Average daily BW gains of cows during the experimental period for the WM and CS were 0.32 and 0.21 kg. The SCC of milk with the WM treatment was slightly higher than the CS treatment group. Reproduction data indicated no difference 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 the wheat middlings byproduct feed was an acceptable and economical component at 10% of the ration DM for early lactation dairy cows.

Key Words: Wheat middlings, Early lactation, Dairy cow

1722 The prediction of potential nutrient supply to dairy cows from field pea (*Pisum sativum*) seeds pressure-toasted at various conditions. P. Yu*¹ and J.O. Goelema², ¹*Department of Animal and Poultry Science, University of Saskatchewan, Canada,* ²*Department of Animal Nutrition, Wageningen Agricultural University, The Netherlands.*

Field pea seeds (*Pisum sativum*, also called marrowfat pea, small blue pea, dry pea, arveja or muttar) have particularly high starch and protein contents (around 45% and 25%, respectively). However their rapid and extensive degradation of protein and starch by rumen microbes make them unsuitable and/or inefficient to be used in the unprocessed form in diets for high producing dairy cows. It is advantageous to have more starch and protein escape degradation in the rumen to provide a source of glucose and amino acid in the small intestine to achieve a higher milk

production. In this study, a systematic research was carried out on the effects of pressure toasting of field pea seeds at various conditions (100, 118 and 136C for 3, 7, 15 and 30 min) on rumen degradability and intestinal digestibility of protein and starch, as measured by in sacco nylon bag and mobile bag techniques in lactation dairy cows and on potential nutrient supply to dairy cows, as predicted by the DVE/OEB model. The results show that with increasing temperatures and times, pressure toasting increased ($P<0.01$) rumen bypass protein (BCP) from 58 to 149 g/kg DM and starch (BSt) from 158 to 248 g/kg DM without negatively affecting intestinal digestibilities, increased ($P<0.01$) intestinally absorbed rumen bypass protein (ABCP) from 54 to 145 g/kg DM and starch (ABSt) from 81 to 190 g/kg DM, increased ($P<0.01$) intestinally absorbable protein (DVE) from 115 to 189 g/kg DM and decreased ($P<0.01$) the degraded protein balance (OEB) from 88 to 25 g/kg DM. The highest increases of BCP, BSt, ABCP, ABSt and DVE were 156, 57, 169, 189 and 64%, respectively and the highest decrease of OEB was 72%, at 136C/15 min, over the raw seeds. The results indicate that the effects of pressure toasting on potential nutrient supply of field pea seeds to dairy cows were very much dependent on the conditions applied during processing. It was concluded that pressure toasting could be used as an effective treatment to increase potential nutrient supply to dairy cows by decreasing the OEB value and increasing the BCP, BSt, ABCP, ABSt and DVE values. The largest response was found after toasting for 15 min at 136C.

Key Words: Pressure toasted peas, DVE/OEB model, Cow

1723 Ruminal degradability of feather meal in tropical crossbred steers. J. Vergara-Lopez*¹, O. Araujo-Febres², Y. Troconis², and M. Lachmann³, ¹*Instituto Nacional de Investigaciones Agrícolas,* ²*Departamento de Zootecnia, Facultad de Agronomía, La Universidad del Zulia,* ³*Departamento de Producción Animal, Facultad de Ciencias Veterinarias, La Universidad del Zulia.*

An evaluation of ruminal degradability of feather meal (FM) was made using two crossbred tropical steers fitted with permanent rumen cannulae. Samples of FM (93.37 and 90.30% DM and OM), corn meal (CM; 92.12 and 87.88% DM and OM) and *Brachiaria humidicola* hay (HH, 92.86 and 87.63% DM and OM) were incubated in the rumen for 0, 1, 2, 4, 6, 12, 24, 36, 48, 60 and 72 h. Dry matter and OM degradabilities were calculated. Dry matter degradability of FM at 72h was 43.0 ± 0.86%, lower than ($P<0.01$) CM and HH (90.70 ± 3.11% and 63.37 ± 0.64, respectively). Organic matter degradability was similar (42.77 ± 0.86, 90.38 ± 3.28% and 62.22 ± 0.75% for FM, CM and HH respectively). Dry matter degradation rate of FM was 0.0115 ± 0.0022, lower than ($P<0.05$) CM 0.0261 ± 0.0048 and HH 0.035 ± 0.012. Organic matter degradation rate was similar (0.0124 ± 0.003, 0.0320 ± 0.009 and 0.0349 ± 0.0117 for HP, HM and HH respectively). Ruminal degradability of FM was lower than of CM and HH. These results suggest that FM may be an important by-product.

Key Words: Feather meal, Ruminal degradability, Tropics

1724 Effect of cull chickpeas variety on apparent digestibility of diets for sheep. G. Quevedo², J. F. Obregon*¹, R. Barajas¹, and A. Estrada¹, ¹*Universidad Autonoma de Sinaloa (Mexico),* ²*DGETA-SEP- Sinaloa (Mexico).*

To determine the effect of chickpeas variety on the apparent digestibility of diets for sheep, 4 lambs (Pelibuey, males, BW = 22.2 kg) were used in a Latin square design experiment. The treatments were: 1) 60% sorghum grain (control) 20:80 roughage:concentrate (13.7% CP and 3.41 Mcal of DE/kg of DM); 2) 30% sorghum and 30% chickpeas variety "Blanco Sinaloa"; 3) 30% chickpeas variety "Tubutama" and 30% sorghum; and 4) 30% chickpeas variety "Porquero" and 30% sorghum. The animals were housed in metabolic crates (1.2 x 0.6 m) and were fed twice a day (3.2% of BW). After 10 d of diet adaptation, samples of food and total feces production were collected for 4 d. Samples were oven dried (110°C 24 h), ashed and CP (N x 6.25; Kjeldhal) analyses were performed. Chickpeas variety had no effect ($P>0.10$) on dry matter digestibility (mean value = 79.5%). Organic matter digestibility was not affected ($P>0.10$) by treatments (mean value = 81.1%). CP digestibility of Porquero variety diet was 3% lower ($P<0.05$) than the other chickpeas varieties (77.48 vs. 79.81%). CP of sorghum diet was 7% less digestible ($P<0.01$) than chickpeas diets (73.33 vs. 79.03%). The DE of diets was not different ($P>0.10$) among treatments (mean value = 3.41 Mcal/kg). Observed/expected DE, was 3% lower ($P<0.05$) in chickpeas diets than

sorghum diet (0.97 vs 1.0) True digestibility of chickpeas crude protein was calculated to be 96% for Blanco Sinaloa and Tubutama varieties, while that for Porquero was estimated to be 89%. The DE content of cull chickpeas was estimated to be similar to sorghum grain (3.79 Mcal/kg). It is concluded that cull chickpeas varieties possess different value as a crude protein source for sheep, but their energy content is not impacted by variety.

Key Words: Chickpeas, Digestibility, Sheep

1725 Effect of feeding dairy cows with whey permeate on ruminal environment under alfalfa grazing conditions. M.C. Gaggiotti¹, M.R. Gallardo¹, A.A. Abdala¹, C. Arakaki², L. Burdisso¹, and A.R. Castillo*¹, ¹INTA-EEA Rafaela, ²INTA-CICV.

Whey permeate is an energetic byproduct resulting from the protein extraction of cheese whey (18% DM and 15% lactose) with a potential use in dairy cattle feeding. The objective was to determine the effects of whey permeate on the rumen environment of dairy cows grazing alfalfa. Six ruminally fistulated dairy cows (541 kg BW; 175 DIM; 15 kg of milk/cow/day) were used in a complete change-over design (2 treatments and two 4 wk periods). The treatments were a control diet (Tc) based on alfalfa pastures (strip-grazing) and 3.5 kg DM/cow/day of ground corn grain; and the whey permeate diet (Tp) where corn grain was replaced by 20 l/cow/day of whey permeate (3.6 kg DM/cow/day). Ground corn grain and whey permeate were supplied twice daily through the rumen cannula at the same time in both treatments (7 and 15 h). Ruminal fluid samples were collected at 6, 9, 12 15 18 21 h and analyzed for pH, NH₃, VFA concentration and total count of amylolytic and cellulolytic bacteria. There were significant differences (p<0.05) in NH₃ (Tc: 16.98 vs Tp: 11.26 mg%), pH (Tc: 6.55 vs Tp: 6.40), acetic acid (Tc: 68.6 vs Tp: 63.8 mM) and butyric acid (Tc: 11.4 vs Tp: 6.52 NMPx10⁹/ml). Although the whey permeate produced a different ruminal environment when it was compared with ground corn grain, this byproduct may be used as an energy source for dairy cows grazing alfalfa pasture.

Key Words: Whey permeate, Grazing dairy cows, Rumen environment

1726 Nutritional value of nonforage fiber sources used by feed industry in Costa Rica. M. Cruz¹, J. Ml. Sanchez*¹, and E. Vargas, ¹Universidad de Costa Rica, San Jose, Costa Rica.

A total of 40 samples of common nonforage fiber sources used in dairy cattle feeding in Costa Rica was taken to estimate their nutritional value. Crude protein, NDF, ADF, lignin, silica, ether extract and ash contents were analyzed. Protein was fractionated and energy content was estimated. Results of soybean hulls had 15.5, 20.3, 32.2, 23.6 and 8.4% of the A, B1, B2, B3 and C protein fractions, respectively. Likewise, palm kernel meal (solvent extracted) had 3.7, 5.8, 8.2, 66.2 and 16.1% of the fractions mentioned before. Rice hulls and corn cobs had low concentrations of CP and high proportions of C fraction, with 53.8 and 56.1%, respectively. Corn bran had the highest hemicellulose content (62.7%) and the lowest levels of lignin (1.1%) and silica (0.04%). Soybean hulls had similar characteristics, however its hemicellulose content was lower than in corn bran and cellulose was higher. Soybean hulls and corn bran had higher (P<0.05) estimated energy values than the other products. In general, soybean hulls had the highest nutritional value because of its protein content and quality, and its energy content.

| Byproduct ¹ | CP | NDF | ADF | Lignin | NFC ² | NE _i | | |
|------------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-------------------|-------------------|-------------------|
| | | | | | | (3x) | NE _m | NE _g |
| % of DM | | | | | | Mcal/kg of DM | | |
| Soybean hulls | 14.0 ^b | 62.7 ^d | 47.0 ^d | 2.6 ^c | 20.3 ^a | 1.43 ^a | 1.55 ^a | 0.95 ^a |
| Rice hulls | 2.6 ^d | 75.7 ^c | 74.0 ^a | 17.3 ^a | 5.9 ^b | 0.26 ^d | 0.08 ^d | 0.00 ^c |
| Palm kernel meal | 16.3 ^a | 84.5 ^b | 57.3 ^b | 15.6 ^b | 4.5 ^{b,c} | 0.90 ^b | 0.93 ^b | 0.38 ^b |
| Corn cobs | 2.5 ^d | 94.1 ^a | 50.8 ^c | 11.0 ^b | 3.2 ^c | 0.72 ^c | 0.71 ^c | 0.17 ^b |
| Corn bran ³ | 5.2 ^c | 74.2 ^c | 19.4 ^c | 1.1 ^e | 20.0 ^a | 1.39 ^a | 1.5 ^{1a} | 0.91 ^a |

(a,b,c,d,e) Means in a column with different superscripts are different (P<0.05) ¹Average of eight samples ²Calculated by difference (NFC=100-NDF-CP-ash-ether extract) ³Byproducts from tortilla industry

Key Words: Nutritional value, Nonforage, Fiber sources

1727 Performance and apparent digestibility of ram lambs fed safflower silage. F.T. Sleiman*¹, O.D. Sayour¹, S.K. Yau¹, M.T. Farran¹, and M.G. Uwayjan¹, ¹American University of Beirut, Beirut, Lebanon.

Nine Awassi ram lambs averaging 43 kg BW were used in a 4-wk digestibility study with 1-wk collection period to determine the effect of feeding safflower silage (SFS) as the sole roughage or in a 1:1 ratio with barley silage (BS) on apparent digestibility and BW change of Awassi ram lambs. The experimental silage treatments were: 1) 100% SFS, 2) 100% BS, and 3) 1SFS: 1BS, mixed at feeding time. In addition to ad libitum silage feeding, each lamb consumed 0.7 kg DM/d concentrate (16.5% CP, on DM basis). All lambs gained weight by the end of the study with the 100% SFS fed lambs having the highest gain (156 g/d). BW change, however, was not significantly different (P>0.05) among treatments. Furthermore, silage DMI was not significantly different (P>0.05) and averaged 1.0 kg DM/d. Apparent digestibilities of DM (79.3, 75.3 and 77.8%) and EE (74.9, 89.2 and 79.8%) were not significantly different (P>0.05) among the 100% SFS, 100% BS and the 1SFS: 1BS fed lambs, respectively. Lambs that received the 100% SFS manifested a significantly higher CP digestibility (P<0.05) than those fed the 100% BS (77.8 vs. 67.9%); whereas CF digestibility was not different (P>0.05) between these two silage groups (83.5 vs. 82.8%). This study indicates that SFS, when adequately prepared, is well accepted and efficiently digested by young ram lambs.

Key Words: Safflower silage, Digestibility, Performance of ram lambs

1728 Potential of apple pulp as silage for ram lambs. F.T. Sleiman*¹, R.A. Sarkis¹, M.G. Uwayjan¹, and M.T. Farran¹, ¹American University of Beirut, Beirut, Lebanon.

Silage characteristics, acceptability and apparent digestibility of ensiled apple pulp were studied using 12 Awassi ram lambs averaging 52 kg BW. The study consisted of a 4-wk trial with 1-wk collection period. The experimental treatments were: I) 100% apple pulp silage (APS), II) 100% barley-vetch silage (BVS), III) 70% APS + 30% ground yellow corn (GYC) and IV) 60% APS + 40% GYC. In addition to ad libitum silage feeding, each ram lamb was offered 1 kg concentrate (14% CP on DM basis). Changes in temperature of treatments containing the APS (I, II and IV) were not significantly different (P>0.05) and averaged for the first 7d after ensiling 18.3, 18.4 and 19.2C, respectively. pH of treatment I was significantly lower (P<0.05) than those of treatments III and IV by 7d after ensiling (3.3 vs. 3.5 and 3.8, respectively) and remained so until 16 d (3.4 vs. 3.5 and 3.9, respectively). Silage DMI was not different among treatments (P>0.05) and averaged 0.4, 0.3, 0.4 and 0.6 kg/d, respectively. All lambs gained weight by the end of study with lambs on treatments I and IV having the highest gains (126 g/d), although changes in BW were not different (P>0.05). Treatments apparent digestibilities of DM (72.3, 69.6, 73.9, and 74.9%), CP (62.9, 62.1, 59.5 and 62.8%) and CF (48.6, 47.3, 40.6 and 38.6%) were not different (P>0.05). The EE digestibility of BVS (II) was significantly higher (P<0.05) than those of treatments I and III (68.5 vs. 42.8 and 47.4%, respectively) but not different (P>0.05) from that of treatment IV (67.1%). Results of this study indicate that apple pulp silage is acceptable and efficiently digested by ram lambs when properly prepared.

Key Words: Apple pulp silage, Apparent digestibility, Ram lambs

1729 Effect of substitution of common beans hay with Sudan grass hay on apparent digestibility of diets for sheep. R. Barajas*¹, J.F. Obregon¹, G. Quevedo², and A. Estrada¹, ¹Universidad Autonoma de Sinaloa, ²DGETA-SEP-Sinaloa.

To determine the effect of substitution of common beans hay (CBH) with Sudan grass hay (SGH) on apparent digestibility of diets for sheep, a digestion experiment was conducted. Four sheep (Pelibuey, males, BW=20.47 kg) were used in a crossover design. The treatments were: 1) Sudan grass hay 40% (11.24% CP and 2.96 Mcal DE/kg), canola meal 14%, sorghum grain 33.6%, sugar cane molasses 10%, urea 0.6%, and mineral premix 1.8%; and 2) A diet similar to control 40% of CBH instead of SGH. The animals were housed in metabolism crates (1.2 x 0.6 m) and were fed twice a day (3.1% of BW). After a 10 d adaptation period to the diet, samples of food and total fecal production were collected for 4 d. Samples were oven dried (110°C, 24 h), ashed and CP (N x 6.25; Kjeldhal) analyses were performed. Dry matter intake was

similar ($P > 0.10$) between treatments. Organic matter intake was higher ($P < 0.05$) in SGH. Intake of CP was higher ($P < 0.01$) in CBH (70.9 vs. 112 g/d). Fecal DM and OM were higher ($P < 0.01$) in SGH than in CBH. Fecal excretion of CP was not affected by treatments ($P > 0.10$). Common beans hay increased ($P < 0.01$) in 6% DM digestibility (69.9 vs. 73.4%). Digestibility of OM was improved ($P < 0.01$) in 9% by CBH. Apparent digestibility of CP was increased ($P < 0.01$) by 16% with the inclusion of CBH (69.1 vs. 80.1%). Observed/expected CP digestibility was not affected ($P > 0.10$) by type of hay supplied (1.12 vs. 1.09). Diet DE was increased ($P < 0.01$) by 10.6% with substitution of SGH for CBH (2.92 vs. 3.23 Mcal/kg). Observed/expected DE content of diets was higher ($P < 0.01$) for CBH than SGH (0.99 vs. 1.09). The DE content of CBH was calculated to be 3.2 Mcal/kg. It is concluded, that common beans hay can be used as ingredient in sheep feeding and that its DE content is approximately 3.2 Mcal/kg.

Key Words: Common beans, Digestibility, Sheep

1730 Ruminal degradation of crude protein of cull chickpeas using nylon bag technique in sheep. J.F. Obregon*¹ and R. Barajas¹, ¹Universidad Autonoma de Sinaloa.

The nylon bag technique was used to determine the ruminal degradation of crude protein of cull chickpeas in sheep. Three sheep (Pelibuey; males, BW=34 kg) were fitted with T cannulas in rumen. The animals were fed a diet containing sudan grass hay 18%, sorghum grain 30%, cull chickpeas 30%, canola meal 10.2%, sugar cane molasses 9%, urea 0.6%, and mineral premix 2.2% (17% CP and 3.34 Mcal DE/kg). Pairs of nylon bags (12 x 18 cm) containing five grams of ground chickpeas (CHP) or soybean meal (SBM) were placed in rumen, and incubated for 2, 4, 6, 8, 12, 16, 20, and 24 h. After removal from the rumen, residual CP content were determined. Solubility was obtained placing the bags in a 0.15 N NaCl solution. Kinetic parameters A, B, and C were calculated for CHP and SBM. Rate of passage of small protein particles (K) was estimated as 0.02 to calculate the effective degradability of CP in rumen. Residual CP values of CHP at 0, 12 and 24 incubation were used to obtain the rumen undegradable crude protein (UCP), taking as reference the value of 20% for SBM. Chickpeas CP was 79% more soluble ($P < 0.01$) than SBM-CP (26.3 vs. 14.6%). The CP disappearance from nylon bags was higher ($P < 0.05$) for CHP than SBM during the first 20 hours of incubation. CP degradability at 24 hours was similar ($P > 0.10$) for CHP and SBM (95.9 vs. 91.8%). The degradation rate of CHP-CP was 0.073 %/h ($R^2 = 0.96$). The effective CP degradation in rumen for CHP was estimated to be 93.7%. The calculated rumen UCP content of chickpeas was 6.5%. It is concluded, that CP of chickpeas is extensively degraded in rumen of sheep, and that its UCP content is close to 6.4%.

Key Words: Chickpeas, Crude protein, Sheep

1731 Ruminal fermentation, digestion kinetics, and nutrient flow in steers fed diets containing poultry manure and urea or blood meal as the main source of nitrogen. J. Mejia-Haro¹, O. Ruiz-Barrera², I. Mejia-Haro³, and J.A. Jimenez-Castro², ¹Universidad de Guanajuato, Mexico, ²Universidad Autonoma de Chihuahua, Mexico, ³CIGA-ITA de Aguascalientes, Mexico.

A study was carried out to evaluate the effects of two sources of nitrogen (poultry manure-urea, and blood meal) and levels of blood meal in diet on ruminal fermentation, digestion kinetics, and nutrient flow of beef steers. Four steers with ruminal and duodenal cannula were assigned to a Latin square design 4 X 4. The treatments were: T0, a control diet with RDP using a poultry manure-urea supplement; T150, a diet with a low level of RUDP, using blood meal (150 g/d); T300, a diet with an intermediate level RUDP (300 g/d); and T450, a diet with a high level of RUDP (450 g/d). The steers were fed twice a day. Before feeding, a chromic oxide bolus (6 g) was placed into the rumen. The experimental period lasted 12 d and the last 5 d, samples of feed, feces, and ruminal and duodenal contents were collected. Data were analyzed by ANOVA using the GLM of SAS (1993). No differences ($P > .05$) were found on the ruminal pH among treatments. T0 presented the highest concentration of ammonia nitrogen ($P < .05$). The total concentration of VFA and the molar proportion of butyric acid were not affected ($P > .05$). However, the molar proportion of acetic and propionic acids were affected ($P < .05$). In the kinetics of the liquid fraction, differences were not observed ($P > .05$) for dilution rate, ruminal volume, turnover time, fluid flow rate, and turnover per day. Similarly, in the kinetics of the

solid fraction, differences were not observed ($P > .05$) for low constant rate, fast constant rate, passage rate, mean retention time, mean retention time in the first compartment, mean retention time in the second compartment and total mean retention time. The duodenal flow of OM, total nitrogen, microbial N, NH₃-N, non-ammonia N and diet N was not affected ($P > .05$) by treatments. Similarly, no differences ($P > .05$) among treatments were found in the ruminal digestibility of OM, microbial and N efficiency. Total apparent digestibility of DM, OM, and N was not different among treatments ($P > .05$). However, the total apparent digestibility of ADF and NDF was affected by treatments ($P < .05$). The lowest value was observed in T0. In general, all the treatments presented a similar pattern in ruminal fermentation, liquid and solid kinetics and the outflow of nutrients to the duodenum.

Key Words: Fermentation, Rumen, Protein

1732 Comparison of nutrient digestibility between Roundup Ready® beets and pulp derived from Roundup Ready® beets and conventional beets and pulps. T. Hvelplund* and M.R. Weisbjerg, Danish Institute of Agricultural Sciences, Denmark.

Roundup Ready® (RR) sugar and fodder beets have been developed, which can tolerate Roundup® (glyphosate) herbicide treatment due to production of the 5-enolpyruvylshikimate-3-phosphate synthase protein (CP4 EPSPS) from *Agrobacterium sp.* strain CP4. The purpose of these experiments was to examine whether RR sugar and fodder beets or pulp derived from RR sugar beets were comparable to conventional (C) beets and pulps with respect to nutrient digestibility. Six varieties of sugar beets (5C+1RR), 5 varieties of fodder beets (4C+1RR) and 6 varieties of beet pulp (5C+1RR) were tested in 3 digestibility experiments with 7 sheep on each treatment. The daily dry matter intake was approx. 950 g (maintenance level), where hay with known digestibility and urea (assumed to be 100% digestible) was included in the diet in all experiments to obtain sufficient nitrogen and structural fiber. The digestibility was estimated for nutrients analyzed according to the Weende analysis, and for ADF, NDF and energy. The digestibility of organic matter varied between 91.8 and 94.6% for fodder beets, where RR variety showed the lowest value. For the sugar beets the variation was between 94.3 and 96.6%, with the RR variety resulting in a value of 94.4%. No significant difference was obtained between C or RR varieties for the main nutrients or energy in the sugar beet or fodder beet experiment. Organic matter digestibility for beet pulp varied between 84.7 and 89.5%, where the RR variety resulted in a value of 85.5%, and significant differences were found for main nutrients and energy digestibility between the highest and lowest C varieties. Organic matter digestibilities obtained for beets were slightly higher and for pulp slightly lower than tabulated values. From these experiments it is concluded that RR sugar and fodder beets, or pulp derived from RR sugar beets, have a nutrient digestibility which is within the range observed for conventional beets and pulps, indicating that feeding value is not influenced by genetic modification.

Key Words: Roundup Ready, Digestibility, Beets and pulp

1733 Growth performance of Xizhen cattle fed either urea or microbial treated rice straw. J. Luo¹, B. Wang*¹, X. F. Zhao², D. H. Tian¹, H. Y. Yang², and Q. Liu³, ¹Northwest Agricultural University, Yangling, Shaanxi, China, ²Animal husbandry bureau of Xixiang county, Xixiang, Shaanxi, China, ³Ankang Agricultural School, Ankang, Shaanxi, China.

In order to utilize the crop residues fully in the rural area of southern Shaanxi province in China, some processing methods were proposed to treat the low quality straw which could be used as animal feeds in dry winter season. The objectives of our study were to determine the nutritive values of microbial and urea treated rice straw, and investigate the growth performance of Xizhen cattle, a local cattle breed in Shaanxi province of China. Wheat bran (1%) was mixed with chopped rice straw (approximately 5 cm in length) before spreading urea and microbial cultures solution, treated mixture was pressed tightly into a square-shaped cement trench lined with a plastic film, after 20 days of fermentation, treated straw was used for feeding. 9 cows aged 1 to 1.5 year-old with 562 kg (± 28.8 kg) weighed BW were randomly divided into three groups: two groups received urea and microbial treated rice straw, the third group, as being the control, received untreated rice straw and 1% wheat bran supplement. The result showed that crude protein, fiber and fat percentage of urea and microbial treated rice straw were 5.5, 29.9, 1.54;

4.8, 30.0, 1.66% respectively; the average BW gain of cows in three groups was 1080, 1004, and 481 g/d in 88 days experimental period; cows fed urea treated rice straw had a greater ($P < 0.05$) BW gain than control, but was similar ($P > 0.05$) to cows fed microbial treated rice straw. The economic analysis suggested a higher profits for cows fed microbial treated rice straw. In conclusion, urea and microbial treated rice straw can be used as a basic diet for cattle during the winter feed deficiency.

Key Words: Urea or Microbial Treatment, Rice Straw, Nutritive Value

1734 Correlation between texture and *in situ* degradation of corn grain. C.E.S. Correa¹, R.D. Shaver², M.N. Pereira^{*1}, J.G. Lauer², and K. Kohn², ¹Universidade Federal de Lavras, Brazil, ²University of Wisconsin, Madison.

We hypothesized that corn kernel texture, measured as vitreousness and density, may be correlated with ruminal *in situ* degradation of corn kernel dry matter and starch. Fourteen American hybrids were harvested at half milk line, black layer, and mature (3-wk past black layer) stages and 5 Brazilian cultivars at maturity. Corn kernel samples were dried at 58 °C for 48 hours; vitreousness was determined by manual dissection of the vitreous endosperm and density was measured using a picnometer. Vitreousness ranged from 32.8 to 79.9 % of the endosperm and density from 1.124 to 1.292 g/cm³ of grain. The correlation between vitreousness and density was 0.87. A near infrared (NIR) curve generated from ground corn kernels had an RSD of 0.86 for vitreousness and 0.77 for density. The NIR technology may be useful for evaluating large corn data sets for differences in kernel texture. A sub-sample of 18 hybrids were ground through a 4 mm mesh screen and incubated *in situ* in 3 ruminally-cannulated Holstein cows in 3 separate non-concurrent trials. Ruminal degradation parameters were determined by non-linear regression for each cultivar. Effective dry matter (EFDM) and starch (EFST) degradation were estimated assuming a ruminal fractional passage rate of 8 %/h. For the 18 hybrids the correlation between kernel texture and effective degradation is reported. We conclude that corn kernel dry matter degradation is a good predictor of starch degradation, allowing for analytical cost savings. Kernel vitreousness and density were negatively associated with ruminal degradation within this corn population.

| | Vitreousness | Density | EFDM |
|------|--------------|---------|------|
| EFDM | -0.88 | -0.83 | |
| EFST | -0.91 | -0.85 | 0.99 |

Key Words: Corn, Starch, Ruminal degradation

1735 Comparative dry matter degradation in rumen of cull chickpeas, soybean meal and sorghum grain using nylon bag technique in rumen of sheep. J.F. Obregon^{*1} and R. Barajas¹, ¹FMVZ- Universidad Autonoma de Sinaloa, Culiacan, Sinaloa Mexico..

To determinate the comparative dry matter degradation in rumen of cull chickpeas, soybean meal and sorghum grain using nylon bag technique in rumen of sheep, an experiment was conducted. Were used three sheep (Pelibuey, males; BW = 34 kg) fitted with canula in rumen. The animals were fed with a 17% CP and 3.34 Mcal DE/kg diet, containing sudan grass hay 18%, sorghum grain 30%, cull chickpeas 30%, canola meal 10.2%, sugar cane molasses 9%, urea 0.6%, and mineral premix 2.2%. Pairs of nylon bags (12 x 18 cm) containing five grams of ground chickpeas (CHP), soybean meal (SBM) or sorghum grain (SGG) were placed in rumen, and incubated by 2, 4, 6, 8, 12, 16, 20 and 24 hours. After removed from rumen, residual DM content was determinate. Solubility was obtained placing the bags in a 0.15 N NaCl solution. Kinetics parameters A, B and C were calculated. Rate of passage of small particles (K) was estimated as 0.02 to calculate the effective degradability of dry matter in rumen. Solubility of CHP-DM was 26% lower ($P < 0.01$) than SBM-DM (17.83 vs. 24.05%). While sorghum-DM solubility represented 6.9% of SBM-DM solubility (24.05 vs. 1.7%). At 12 hours incubation time, ruminal degradation of CHP-DM was 33% higher ($P < 0.01$) than SBM-DM (72.71 vs. 54.84%). Sorghum-DM degradation was 54% lower ($P < 0.01$) than CHP-DM (72.71 vs. 33.09%). After 24 hours incubation, CHP-DM was 43% more degraded in rumen ($P < 0.01$)

than SGG-DM (95.9 vs. 67.2). Effective degradation of chickpeas dry matter was calculate in 92.3%. Rate of disappearance of DM from nylon bags were: 0.083%/h ($R^2 = 0.98$), 0.027%/h ($R^2 = 0.99$) and 0.027%/h ($R^2 = 0.99$) for CHP, SBM and SGG, respectively. It is concluded, that chickpeas dry matter is highly degraded in rumen and that is disappearance rate is faster than soybean meal and sorghum grain dry matter in rumen of sheep.

Key Words: Chickpeas, Degradability, Sheep

1736 Ruminal *in situ* degradation was lower for Brazilian than United States corn grains. C.E.S. Correa¹, R.D. Shaver², M.N. Pereira^{*1}, J.G. Lauer², and K. Kohn², ¹Universidade Federal de Lavras, Brazil, ²University of Wisconsin, Madison.

Flint versus dent endosperm is predominant in Brazilian (BRA) versus United States (US) corn markets. We evaluated differences in corn kernel texture between countries and its effect on ruminal *in situ* starch degradation. Fourteen US and 5 BRA hybrids, cultivated in their respective countries and harvested at maturity, were ranked by vitreousness as measured by manual dissection of vitreous endosperm. Within each country three hybrids were chosen to represent the extremes of vitreousness. Mean vitreousness of US hybrids was 47.0% (42.3, 49.6 and 53.9%) and 73.2% (65.3, 68.7 and 78.3%) for BRA hybrids. Corn kernels were ground through a 4 mm mesh screen and incubated *in situ* in 3 ruminally cannulated Holstein cows. Ruminal starch degradation parameters were determined by non-linear regression. Effective starch (EFST) degradation was estimated assuming a fractional passage rate of 8 %/h. In a second *in situ* trial, two US hybrids of high (55.2%) or low (36.3%) vitreousness were harvested at half milk line, black layer, and mature (3-wk past black layer) stages. Average EFST was 78.7% for the low and 67.4% for the high vitreousness hybrids ($P < .001$). The hybrid with high vitreousness had a greater decrease in ruminal starch degradation with advancing maturity ($P < .01$ for the interaction between hybrid and maturity). Starch digestion may be a major concern in BRA hybrids, especially in situations of delayed harvest.

| | US hybrids | BRA hybrids | P value |
|---|------------|-------------|---------|
| Fractional rate of starch degradation (%/h) | 19.4 | 7.0 | <.001 |
| Rapidly degraded A fraction (% of starch) | 31.0 | 6.1 | <.001 |
| EFST (% of starch) | 77.4 | 48.5 | <.001 |

Key Words: Corn, Starch, Ruminal degradation

1737 Evaluation of water powered liquid metering system to provide molasses for lactating dairy cattle on pasture. J.L. Amick*, L.D. Muller, D.R. Buckmaster, H.D. Karsten, T.W. Cassidy, and E.M. Seconi, The Pennsylvania State University, University Park, PA.

Grazing lactating dairy cattle were fed isoenergetic ratios of concentrate (C) or concentrate (minus 1.05 kg DM) + liquid molasses (1.05 kg DM/cow/day) (CM) to evaluate the effectiveness of a liquid metering system powered by pressurized water to deliver molasses to grazing dairy cattle. Fourteen Holstein cows (97 DIM, 44 kg milk/day, 567 kg BW, 2.6 BCS) grazed alfalfa (*Medicago sativa* L) (20.2% NDF, 28.4% CP, 67.2% IVDMD) in a single reversal design with 14 days/period. Cows grazed in a rotational grazing system with adjacent plots where the C received water and the CM received water containing the molasses. Water consumption was greater for CM than for C (79.4 vs. 62.5 L/cow/day. $P < 0.05$) and resulted in 1.05 kg/cow/d molasses DMI. Cows were milked twice daily and individually fed concentrate after each milking. Milk production (33 kg/d) and composition (2.6% fat, 2.8% protein, 13.8 mg/dl MUN) did not differ ($P > 0.05$) between groups. Feed intake, determined using Cr₂O₃, did not differ ($P > 0.05$) between treatments (22.8 kg/cow/d). Blood concentrations of urea nitrogen (16.7 mg/dl), glucose (66.1 mg/dl) and NEFA (207 µeq/L) were not different ($P > 0.05$). The water-powered liquid metering system increased water intake, provided molasses throughout the 24-hour grazing period, and effectively controlled liquid supplement intake. Milk production, milk

composition, DMI, and blood metabolites were not different when compared to feeding grazing cows a grain supplement without molasses.

Key Words: pasture, supplementation, molasses

1738 Effect of corn grain texture and maturity on ruminal *in situ* degradation. G.A. Caestine, M.N. Pereira*, R.G.S. Bruno, R.G. Von Pinho, and C.E.S. Correa, *Universidade Federal de Lavras, Brazil.*

Dent (AG 1051, AG 4051) and flint (AG 9012, Tork) corn cultivars were cultivated in five 7-m rows and harvested at early dent (ED), half milk line (HL), and black layer stages (BL). Each grain was frozen-cut into four pieces for ruminal incubation into 6 rumen-cannulated cows. The disappearance of dry matter over 24 hours (DEG24) and the residue of 72-hour (RES72) incubations were recorded. A sample was dried at 58 °C for 96 hours to determine dry matter content (DM) and vitreousness (Vitre) measured by manual dissection of vitreous endosperm. *In situ* data were analyzed within cow and least square means for each hybrid used to correlate *in situ* parameters with DM and Vitre. Linear and quadratic contrasts for maturity were evaluated. The quadratic decrease in ruminal digestion reflected a linear increase in Vitre and DM, factors beyond moisture and presence of hard endosperm may be involved in digestion responses. Correlation of DEG24 and DM was greater than with Vitre (-0.88 vs -0.61). However, correlations between Vitre and DEG24 were higher when performed within texture, and as high as with DM for dented corn. The harvesting window of flint corn is apparently shorter than for dented if starch digestion is a concern. Texture had a greater impact on ruminal digestion at the BL stage of growth.

| | DEG24 (% of grain DM) | RES72 (% of grain DM) | Vitre (% of endosperm) | DM (% of grain) |
|-----------|--------------------------|--------------------------|------------------------------|-----------------------|
| Flint/ED | 73.3 | 1.9 | 59.9 | 60.0 |
| Flint/HL | 65.0 | 3.7 | 67.0 | 64.5 |
| Flint/BL | 19.0 | 41.1 | 74.2 | 78.4 |
| Dent/ED | 86.2 | 1.2 | 38.2 | 54.5 |
| Dent/HL | 61.4 | 4.8 | 46.9 | 62.4 |
| Dent/BL | 42.3 | 16.9 | 47.9 | 74.2 |
| SEM | 2.8 | 1.1 | 2.7 | 2.6 |
| Texture | <.001 | <.001 | <.001 | .12 |
| Maturity | <.001 | <.001 | .01 | .001 |
| T*M | <.001 | <.001 | .54 | .82 |
| Linear | <.001 | <.001 | <.01 | <.001 |
| Quadratic | .002 | <.001 | .45 | .20 |

Key Words: Corn, Texture, Ruminal degradation

1739 Optimal inclusion level of a raw soybean hull-corn steep liquor pellet in diets for lactating dairy cows. J. M. DeFrain*¹, J. E. Shirley¹, E. C. Titgemeyer¹, A. F. Park¹, and R. T. Ethington², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Inc.

Forty multiparous Holstein cows (255 ± 135 DIM; 28 ± 6 kg/d milk) were used in a randomized block design to determine the optimal inclusion level of a raw soybean hull-corn steep liquor pellet (SHSL). Cows were blocked by pretreatment ECM, BW, and BCS and assigned to one of five diets: 0, 10, 20, 30, or 40% SHSL (DM basis). Diet CP averaged 17%. The 0% SHSL diet contained 30.2% alfalfa hay (AH), 15.2% corn silage (CS), 30.7% corn, 9.4% whole cottonseed, 6% soybean meal (SBM), 4% expeller SBM, 1% wet molasses, and 3.5% vitamin/minerals. SHSL incrementally replaced up to 12.5% AH, 7.1% CS, 12.7% corn, and 7.2% SBM. Cows were fed diets for 11 d. Milk yield (2-d average) and milk composition were measured prior to initiation of treatment for covariate analysis and at the end of the trial. Blood was collected on d 11. A quadratic response (P = 0.01) was observed for DMI with cows fed 30% SHSL consuming the least. A significant cubic effect (P < 0.05) was observed for ECM yield and efficiency as cows fed 10, 20, or 40% SHSL produced more ECM, more efficiently than cows fed diets containing 0 or 30% SHSL. Percent fat, protein, and SNF in milk were not affected by diet, but corresponding yields (kg/d) responded cubically (P < 0.01), similar to ECM. MUN was higher for cows fed 40% SHSL than those

fed other diets. Concentrations of glucose and urea in plasma were similar among diets, but quadratic responses (P < 0.05) were observed for plasma Lys, Leu, Trp, Tyr, total essential amino acids, and total amino acids, which were all higher for intermediate levels of SHSL. These data indicate SHSL up to 40% of diet DM is an acceptable feedstuff for lactating dairy cows during short term feeding periods. Longer term studies are warranted. Based on efficiency of ECM production, 20% of diet DM was the optimal inclusion level for SHSL in diets fed to lactating dairy cows.

Key Words: Soybean hulls, Steep liquor, By-product

1740 Corn crop residue grazing effects on soil physical properties and soybean production in a corn-soybean crop rotation. J. R. Russell¹, J. T. Clark*¹, D. L. Karlen², W. D. Busby¹, L. J. Secor¹, B. Peterson³, C. R. Olsen¹, and S. C. Shouse¹, ¹Iowa State University, ²National Soil Tilth Laboratory, ³USDA Natural Resource Conservation Service.

To evaluate the effects of crop residue grazing by beef cows on soil characteristics and soybean yields, a 19.4-ha field near Atlantic, IA and 14.6-ha field near Chariton, IA were divided into four blocks of 6 paddocks. Twelve beef cows were allotted to graze five of the paddocks at 28-d periods beginning on October 15 and November 29 at the Atlantic and Chariton sites. Twelve grazing exclosures were placed in two transects within each grazed paddock. Precipitation and soil temperature, bulk density, moisture content, penetration resistance, surface roughness, classification, topsoil depth, and crop residue cover were measured. Soil bulk density, moisture content, and penetration resistance in grazed paddocks were measured to a depth of 20.3 cm outside and inside grazing exclosures and expressed as the outside-to-inside ratio. In the subsequent growing season, soybeans were planted in replicate fields with disking or no tillage and yield determined at harvest. At the Atlantic site, the ratios of the soil bulk density outside to that inside grazing exclosures at a depth of 0 to 10.2 cm were greater (P < .06) in paddocks grazed in periods 1, 2, 3 and 5 and soil surface roughnesses were greater (P < .01) in paddocks grazed in period 5 than ungrazed paddocks. At the Chariton site, soil surface roughnesses (P < .01) were greater in paddocks grazed in periods 2, 3, and 4, ratios of penetration resistance to a depth of 10.2 cm outside to inside grazing exclosures were greater (P = .01) in periods 2, 4, and 5, and postgrazing residue covers were lower (P < .01) in all grazed paddocks than ungrazed paddocks. At both sites, soybean yields in the season following grazing did not differ between grazed and ungrazed paddocks. In stepwise multiple regressions using data from both sites, soybean yields (kg/ha) were predicted by soil clay % (y = 5672.65 - 112.73x; r² = .91).

Key Words: Corn crop residues, Grazing, Soil

1741 Dynamics of the nutrients in the gastrointestinal tract: Validation of the Cornell system for bovine fed with sugar cane based diets. E. S. Pereira*¹, A. C. Queiroz², S. C. Valadares Filho², L. F. Miranda³, and A. M. V. Arruda¹, ¹Universidade Estadual Oeste Paran, ²Universidade Federal Viosa, ³Universidade Federal Minas Gerais, Brazil.

The objective of this work was to validate the predictions with base in the estimates of the dynamic ruminal and post-ruminal parameters of the nutrients and of the microbial growth at the rumen level, using the equations that compose the submodel Cornell system relative to the gastrointestinal tract. Four Holstein-Zebu young bulls with average 300 kg LW, rumen and abomasal fistulated were allotted to 4 x 4 Latin square design in a 2 x 2 factorial arrangement. The animals were fed with sugar cane based, diets, supplemented with two nitrogen sources (urea or poultry litter) and two daily levels of *Sacharomyces cerevisiae* addition (0 or 10 g/animal). The indigestible neutral detergent fiber (NDF) and chromium mordant sugar-cane NDF were used as internal and external markers, to estimate the daily fecal production and the ruminal particle passage rates. The dynamics of the nutrients was based on the determinations of the total nitrogen flow and of the of abomasal nitrogen flow of microbial origin, of the total and NDF digested in the rumen. These variables were also predicted from the model described in the Cornell system, for validation of its estimates. The microbial yield was not influenced by the nitrogenous sources or by *Sacharomyces cerevisiae* addition. The simulation of the Cornell system resulted in overestimation of the total ruminal carbohydrates digestion (51%) and NDF degraded in the rumen (47%), the nitrogen flow of microbial origin (86%) and

underestimated the total nitrogen flow (73%). The CNCPS model did not present a realistic prediction of the dynamics of the nutrients in the gastrointestinal tract.

Key Words: Microbial efficiency, CNCPS system, Rate of passage

1742 Determination of the protein and carbohydrates fractions, and in vitro degradation rates of the sugar cane, poultry litter and cottonseed meal. E. S. Pereira^{*1}, A. C. Queiroz², S. C. Valadares Filho², L. F. Miranda³, and A. M. V. Arruda¹, ¹Universidade Estadual Oeste Parana, ²Universidade Federal Viosa, ³Universidade Federal Minas Gerais, Brazil.

The objective was to fractionate and examine the degradation kinetics of the nitrogenous compounds and the carbohydrates of the sugar cane, poultry litter and cottonseed meal. The non-protein nitrogenous compounds, soluble and insoluble nitrogen in borate-phosphate buffer, neutral detergent and in acid detergent insoluble protein nitrogen were analyzed for the determination of the nitrogen fractions. The degradation rates of the protein fractions were obtained from the in vitro incubation of the feeds with proteases isolated from ruminal fluid. The total carbohydrates, and the fractions C, B2 and the soluble neutral detergent components were calculated for the determination of the carbohydrates using the Cornell system. The potentially degradable (B2) and undegradable (C) fractions of the neutral detergent fiber, corrected for ash and protein, the lag dynamic rates, of degradation and of specific microbial growth, from the fraction B2, were determined. The coefficient of degradability and the NDF ruminal repletion effect of the feeds, were also determined. The values of 71.01; 45.80 and 71.66% of the fraction B2 of the nitrogenous compounds were observed for sugar cane, poultry litter and cottonseed meal, respectively. The poultry litter stood out for the highest B3 and C fraction (23.57 and 10.11%). The B3 fraction degradation rates were of 0.03; 0.031 and 0.09 h⁻¹ for sugarcane, poultry litter and cottonseed meal, respectively. The fraction C of the carbohydrates varied of 22.74; 28.00 and 32.64% for the three feeds, respectively. The sugar cane presented high soluble components fraction (35.99%), however presented low digestion of the potentially degradable fiber (3.41% h⁻¹) and a significant repletion effect (6.6 h⁻¹). The feeds, sugarcane and poultry litter present low nutritional value to meet the ruminal microorganisms and of the host requirements.

Key Words: Carbohydrate, Protein, Rumen

1743 Effect of whole or ground cottonseed on apparent digestibility of finishing diets for sheep. A. Estrada^{*1}, J.F. Obregon¹, R. Barajas¹, and B. Valenzuela¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

The objective of this study was to determine the apparent digestibility of whole or ground cottonseed in finishing diets of sheep. Four sheep (Pelibuey, males, BW=25.9 kg) were used in a crossover design experiment. The treatments were: 1) ground cottonseed 20%(GCS), sudan grass 12%, sorghum grain 50%, canola meal 5.2%, sugar cane molasses 10%, urea 0.8%, and mineral premix 2% (15.3% CP and 3.47 Mcal DE/kg); 2) A diet similar to control but containing whole cottonseed 20% (WCS) instead of ground cottonseed. The animals were housed in metabolic crates (1.2 x 0.6 m) and were fed twice daily (3.1% of BW). After a 10d dietary adaptation period, samples of food and total fecal production were collected across 4 d. Samples were oven dried (110 °C, 24 h), and DM and CP (N x 6.25; Kjeldhal) analyses were performed. Dry matter intake and crude protein intake were not affected (P>0.10) by treatment. Dry matter excreted in feces increased (P<0.04) in 14.7% with whole cottonseed treatment (170 vs. 195 g/day). Crude protein excreted in feces was not affected by treatments (P>0.10) with mean value of 22.3 g/day. The inclusion of whole cottonseed decreased (P>0.04) by 4.4% the apparent digestibility of diet dry matter (75.2 vs. 71.9%). Crude protein digestibility was not affected (P>0.10) by processing of cottonseed (P>0.10). The mean of experiment was 78.9%. DE of the diet was 4.4% lower (P<0.01) in whole cottonseed than in ground cottonseed diet (3.21 vs. 3.07 Mcal DE/kg). Observed/expected DE was lower (P<0.01) in WCS than in GCS diet (0.88 vs. 0.93). DE content of whole cottonseed was estimated to be 3.53 Mcal/kg. Whole cottonseed possesses a lower nutritional value than ground cottonseed for sheep fed finishing diets, and that WCS-DE content is near of 3.5 Mcal/kg.

Key Words: Cottonseed, Digestibility, Sheep

1744 Effect of feeding foliage of a multipurpose tree (*Enterolobium cyclocarpum*) on ciliate protozoa and ruminal fermentation in sheep. K. M. Koenig^{*1}, M. Ivan¹, B. Teferedenge², L. M. Rode¹, M. Ibrahim³, D. P. Morgavi¹, and C. J. Newbold², ¹Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB Canada, ²Rowett Research Institute, Aberdeen, Scotland, ³CATIE, Turrialba, Costa Rica.

The effect of feeding foliage of *Enterolobium cyclocarpum* on ciliate protozoal numbers and rumen fermentation was measured in three groups of five ruminally cannulated wethers with either no ruminal protozoa (fauna-free), a normal mixed protozoal population, or genera of *Entodinium* as a single species rumen fauna. Repeated measurements were made on the sheep in two periods of 28 d. The control diet was a total mixed ration composed (DM basis) of barley silage (60%), and a barley grain and soybean meal pelleted concentrate (40%). The diet was offered twice a day and feed was restricted to 85% of ad libitum intake from d 12 to 28. In the second period, 200 g (93.7% DM) of *E. cyclocarpum* was substituted for an equal amount of diet DM offered at the morning feeding, and fed from d 16 to 28. Rumen contents were collected at various times over the last 5 d of each period (d 9 to 13 of *E. cyclocarpum* feeding) for measurement of volatile fatty acids, NH₃-N, and protozoal numbers, and then averaged for statistical analysis. Total protozoal numbers were lower in sheep faunated with a normal mixed protozoal population compared to sheep monofaunated with *Entodinium spp.* Feeding the foliage of *E. cyclocarpum* tended (P = 0.065) to reduce protozoal numbers by 25%. Total volatile fatty acid concentration was higher and NH₃-N concentration lower in sheep fed *E. cyclocarpum* suggesting that ruminal digestion was not compromised and that the turnover of microbial protein in the rumen was reduced by the anti-protozoal effect of *E. cyclocarpum*. In a second experiment, eight ruminally cannulated sheep with a normal mixed ruminal protozoal population were fed the control diet or the control diet supplemented with 200 g *E. cyclocarpum* for a period of 42 d. Rumen contents were collected 2 h after feeding for protozoal enumeration to determine the persistence of the anti-protozoal effect of *E. cyclocarpum*. Protozoal numbers were reduced in sheep fed *E. cyclocarpum* from d 5 to 11, and then protozoal numbers recovered to the levels in the control animals. In conclusion, feeding the foliage of *E. cyclocarpum* reduced ruminal ciliate protozoal numbers, but the effect was transitory.

Key Words: protozoa, defaunation, ruminal fermentation

1745 Effect of subacute ruminal acidosis on in situ digestion of mixed hay in lactating dairy cows. J.C. Plaizier^{*1}, J.E. Keunen², J-P. Walton², T.F. Duffield³, and B.W. McBride², ¹Department of Animal Science, University of Manitoba, ²Department of Animal and Poultry Science, University of Guelph, ³Ontario Veterinary College.

It is expected that subacute ruminal acidosis (SARA) reduces fiber digestion, since low rumen pH (< 6) reduces growth yield and increases maintenance requirements of fibrolytic microflora. Additionally, low rumen pH might reduce the effect of fibrolytic enzymes. Previous investigations on the effect of rumen pH on fiber digestion have been conducted in vitro. The extent of NDF digestion determined in situ is generally greater than that determined in vitro. Hence, results from earlier in vitro studies might not be fully indicative for the effect of SARA on ruminal digestibility. Using a previously developed nutritional model to induce low rumen pH, the effect of SARA on rumen DM and NDF degradability of mixed hay was determined. SARA was induced by replacing 25% of the ad libitum DM intake of total mixed ration (TMR) with grain pellets (50% wheat/50% barley). Rumen pH was measured continuously using in-dwelling probes. In situ degradability was determined by incubating nitrogen free polyester bags with a pore size of 50 microns containing 2 g of ground dried hay in the rumen for 3, 6, 12, 24, 48 and 72 h. The nutritional model resulted in a substantial drop in rumen pH. Rumen pH in control cows was lower than that normally observed in lactating dairy cows. This was most likely due to the absence of bicarbonate from the TMR. The model had a much larger effect on the time below pH 6 and time below pH 5.6, than on average daily rumen pH (see table below). Hence, the latter two measures are more indicative of SARA than average daily rumen pH. The model resulted in a large reduction of in situ degradability of DM and NDF. NDF degradability was more affected than DM degradability (see table below). This study suggests that induction of SARA by excess feeding

of wheat/barley pellets reduces the ruminal digestion of DM and NDF from mixed hay substantially.

| | Treatment | | | |
|-----------------------|-----------|---------|------|---------|
| | SARA | Control | SE | P |
| Avg. rumen pH | 5.87 | 6.08 | 0.04 | < 0.05 |
| Time < pH 6 (min/d) | 916 | 547 | 63.4 | < 0.005 |
| Time < pH 5.6 (min/d) | 353 | 152 | 31.9 | < 0.001 |
| DM 24 h degr. (%) | 52.9 | 56.4 | 0.84 | < 0.05 |
| DM 48 h degr. (%) | 59.6 | 64.1 | 0.46 | < 0.01 |
| NDF 24 h degr. (%) | 21.8 | 27.2 | 1.32 | < 0.05 |
| NDF 48 h degr. (%) | 30.9 | 39.5 | 1.05 | < 0.01 |

Key Words: Sub-acute ruminal acidosis, Fiber digestibility, Dairy cows

1746 Diets with high non-fiber carbohydrate and different solubilities for Llamas (*Lama glama*): effects on digestive activity in compartment 1 of the digestive system. M. Sol Morales^{*1}, R. Cabrera¹, A. Lopez¹, C. Carvajal¹, J. Gutierrez¹, and M. Goic¹, ¹Facultad Ciencias Veterinarias y Pecuarias, Universidad de Chile, Santiago, Chile.

A 2x2 latin square experiment was used to characterize digestion of high carbohydrate diets in llamas. Two female llamas, cannulated in compartment 1 (C1), were fed diets containing 40% alfalfa hay; carbohydrate sources differed in solubility. Diet 1 (D1, high degradation rate): beet molasses and oats (12 and 48% of diet DM) and Diet 2 (D2, low degradation rate): dried beet pulp and corn grain (21.7 and 32.3% of diet DM). Both diets had 3.34 Mcal/kg of DE, and NFE/CF ratio of 3.46 to assure bacterial protein synthesis (Hagemeister et al, 1981). Contents of CP and NDF were 13.6 and 34.3, and 11.6 and 41.9 (%) for D1 and D2. The diets were ground (5mm) and fed for 2 h/day. Each experimental period consisted of 15 days as adaptation period, and sampling at days 16, 18 and 20. In sacco 24 h DM degradability (DMD) (Mehrez and Orskov, 1977) was determined simultaneously with sampling of C1 content at 0, 1, 2, 4, 8 and 12 h after feeding to measure pH, VFA and NH₄ concentrations. The DMD at 24 h (%) assessed by Orskov and MacDonald (1979) was 73.9 and 72.7, and the a, b and c parameters of the DMD curve were: 59.45, 22.44, 0.043 and 24.15, 55.59, 0.086 respectively for D1 and D2. The parameters of the C1 (D1 and D2, respectively), were: pH, 7.00 and 6.95; total VFA (mM), 54.0 and 49.4; acetate, 39.9 and 34.9; propionate, 8.5 and 7.0; butyrate, 7.6 and 5.9 and NH₄, 16.9 and 16.4 (mg/dl) were not affected (P>0.05) by the diets. Only pH and NH₄ were different (P<0.05) with hour after feeding. Although there were no differences in utilization of these carbohydrate sources by Llamas, the high buffer capacity of C1 was clearly shown by the pH values obtained (lowest values occurring at 2h after feeding were 6.6 and 6.9 for D1 and D2, respectively). Excessive foaming occurred in one llama fed with D1. These results extend the data base for digestion in llamas from that reported last year evaluating mixed forage diets in llamas. FONDECYT Project 1980-769

Key Words: Llamas, Rumen

1747 Improving the nutritional value of oat hulls for ruminant animals: Study of synergistic interaction between *Aspergillus ferulic acid esterase* and *Trichoderma xylanase* on release of hydroxycinnamic acids from oat hulls. P. Yu^{*1}, J.J. McKinnon¹, D.D. Maenz¹, V.J. Racz^{1,2}, and D.A. Christensen¹, ¹Department of Animal and Poultry Science, University of Saskatchewan, Canada, ²Prairie Feed Resource Centre Inc., Canada.

Oat hulls, a byproduct from the milling process, contain relatively high amounts of hydroxycinnamic acids, mainly *p*-coumaric (PCA: 4-hydroxy-cinnamic) and ferulic (FA: 4-hydroxy-3-methoxycinnamic) acids. These components are believed to be inhibitory to oat hull biodegradability by rumen microorganisms. Previous research has shown that release of FA and PCA by a novel enzyme - *Aspergillus ferulic acid esterase* (A-FAE) was dependent upon particle size ($\leq 250 \mu\text{m}$) of oat hulls and the presence of *Trichoderma xylanase* (T-XYL). In this paper, a further study of the synergistic interaction between A-FAE and T-XYL at different levels (A-FAE at 13 mU, 800 mU and 409.6 U/assay; T-XYL at 1 U, 256 U and 4096 U/assay) on the quantitative release of FA and PCA from oat hulls was carried out. Total alkali-extractable FA and PCA in the oat hulls used in this study were 3.83 $\mu\text{g}/\text{mg}$ and

5.21 $\mu\text{g}/\text{mg}$, respectively. The results indicated that relative to A-FAE alone, the synergistic action of A-FAE and T-XYL was superior in causing the release of FA, indicating that T-XYL is important in acting with A-FAE in the degradation of feruloyl-polysaccharides of oat hulls. Averaged across FAE concentrations, increasing T-XYL level from 1 U to 256 U to 4096 U/assay resulted in an increase (P<0.001) in FA release from 5.6 to 15.0 to 37.5% and PCA from 2.7 to 5.6 to 7.8%, respectively. In contrast, averaged across T-XYL concentrations, increasing A-FAE from 13 mU to 800 mU to 409.6 U/assay resulted in the release of FA and PCA being only slightly increased from 17.5 to 18.6 to 22.0% and from 4.6 to 5.0 to 6.6%, respectively. There was no extensive release of PCA by A-FAE in both the absence and presence of T-XYL, indicating a specificity of A-FAE which only efficiently releases FA and not PCA from oat hulls. Polynomial regression indicated that T-XYL had significant (P<0.001) linear and quadratic effects on FA release (R² 0.91 and 0.89, respectively). This study suggests that a low level of A-FAE (13 mU) with a high level of T-XYL (4096 U) is able to sufficiently break the ester linkage between FA and the attached sugar, releasing FA from oat hulls. This action which causes disruption of crosslinks has the potential to improve hydrolysis of the remaining polysaccharides by rumen micro-organisms which, in turn, would improve rumen degradability of oat hulls.

Key Words: Hydroxycinnamic acids, Ferulic acid esterase, Oat hulls

1748 Effect of supplementation on rate of neutral detergent fiber degradation in forages measured *in situ* and by rumen evacuation. M.R. Weisbjerg^{*}, P. Lund, and T. Hvelplund, Danish Institute of Agricultural Sciences, Denmark.

Forage neutral detergent fiber (NDF) digestibility is highly variable depending on type and maturity of forage and ration composition. The aim of these experiments was to estimate rate of degradation (k_d) for digestible NDF (dNDF) for different forages with and without concentrate supplementation, and to compare the *in situ* method with the rumen evacuation method (REM), as REM is believed to give true values. Four forages; early cut grass silage (ECGS), late cut grass silage (LCGS), whole crop barley silage (WCBS) and grass hay (GH) were compared in two 4x4 Latin squares using rumen, duodenal and ileal fistulated dairy cows. Forages were fed ad libitum, as the only feed in exp. 1, and in exp. 2 supplemented with low fiber concentrates (kg DM/d; 4.5 wheat flour and 1.3 soybean meal). *In situ* k_d of dNDF was estimated using a degradation model including lag time. k_d based on REM was calculated as rumen disappearance of dNDF divided by rumen dNDF pool. Rumen pool was the mean from three different evacuation times over the day. Neutral detergent fiber contents in forage DM were 47, 61, 47 and 65%, and potential NDF digestibilities (21 d rumen *in situ* incubation) were 90, 78, 72 and 80% for ECGS, LCGS, WCBS and GH, respectively. Concentrate supplementation reduced k_d for dNDF measured by REM from 5.4, 3.4, 2.8 and 2.9 ± 0.9 %/h to 3.0, 3.1, 1.8 and 2.3 ± 0.3 %/h for ECGS, LCGS, WCBS and GH, respectively. In contrast *in situ* k_d for dNDF increased by supplementation. The *in situ* method slightly overestimated k_d in unsupplemented diets compared to REM, and the *in situ* k_d overestimation thus became more pronounced in supplemented rations. The negative effect of supplementation on k_d for dNDF found using REM was supported by the reduction in total tract NDF digestibilities due to supplementation from 81, 64, 54 and 62 $\pm 3\%$ to 70, 63, 37 and 52 $\pm 4\%$ for ECGS, LCGS, WCBS and GH, respectively. This indicates that the REM method gives reliable results but the *in situ* method overestimates k_d for dNDF especially in supplemented rations.

Key Words: NDF, Degradation rate, Rumen evacuation

1749 Mean ruminal retention time of fiber measured using indigestible neutral detergent fiber or ytterbium-labelled feed. P. Lund^{*}, M.R. Weisbjerg, and T. Hvelplund, Danish Institute of Agricultural Sciences.

It is well known that a long mean ruminal retention time (MRT) improves digestibility of fiber. However this may also restrict feed intake. Six forages; early cut grass silage (ECGS), late cut grass silage (LCGS), whole crop barley silage (WCBS), grass hay (GH), maize silage (MS) and alfalfa hay (AH) were compared using fistulated dairy cows in 4 Latin square experiments (A,B,C,D). Forages were fed ad libitum as the only feed (A, C) or supplemented (B, D) with (kg DM/d; 4.5 wheat flour and 1.3 soybean meal). Mean ruminal retention time was determined based

either on rumen pool of indigestible NDF (INDF) divided by duodenal flow of INDF; or on duodenal concentration of ytterbium (Yb) fitted to a two compartment mathematical model with age-dependency in the first compartment (G3G1), subsequent to a pulse dose of Yb-labelled neutral detergent fiber (NDF) from the respective feeds. Supplementation seemed to decrease MRT based on Yb-labelled feeds, whereas the results were less conclusive based on INDF, where supplementation seemed to increase MRT for LCGS and WCBS. Though both methods predicted the highest MRT for unsupplemented GH and the lowest MRT for supplemented MS and AH, correlation between the two methods was moderate ($r=0.61$, 60 obs.). As INDF in contrary to NDF is an ideal nutritional entity, the INDF method is believed to give true values for MRT of INDF and also good estimates for MRT of NDF. Mean ruminal retention time calculated based on Yb-labelled feed was underestimated compared to MRT of INDF. This indicates a migration of Yb from the particulate matter to the liquid pool and from large to small particles in the rumen. Therefore, results from the Yb-method should not be used as absolute values, but are useful to describe the age-dependency of passage.

| Method | INDF | INDF | Yb | Yb |
|-----------------|----------------|----------------|---------------|---------------|
| Supplementation | No | Yes | No | Yes |
| Experiment | A (± 20) | B (± 10) | A (± 3) | B (± 3) |
| ECGS | 85 | 70 | 46 | 40 |
| LCGS | 63 | 80 | 47 | 41 |
| WCBS | 55 | 73 | 42 | 44 |
| Experiment | C (± 10) | D (± 4) | C (± 3) | D (± 2) |
| GH | 90 | 80 | 49 | 40 |
| MS | 54 | 41 | 41 | 36 |
| AH | 70 | 53 | 44 | 32 |

Key Words: Mean ruminal retention time, Rumen evacuation, Ytterbium

1750 Effects of physically effective fiber on chewing activity and rumen fermentation of dairy cows fed barley-based diets. W. Z. Yang^{*1}, K. A. Beauchemin¹, and L. M. Rode², ¹Agriculture and Agri-Food Canada, ²Bioavance Technologies Inc.

Dietary factors that alter the intake of physically effective fiber (peNDF) were evaluated for their effects on chewing activity and rumen fermentation using a double 4 x 4 Quasi-Latin square design with a 2 x 3 factorial arrangement of treatments. The dietary factors were: kernel thickness of processed barley grain, coarse (1.60 mm) or flat (1.36 mm); forage to concentrate ratio (F:C), low (35:65) or high (55:45); and forage particle size, long (7.59 mm) or short (6.08 mm). Eight lactating cows were offered ad libitum access to a total mixed diet (TMR). The peNDF contents in the diets were measured as the total proportion of the sample retained on both sieves of the Penn State Particle Separator (PSPS) or as the proportion retained on a 1.18 mm screen as proposed by Mertens (1997; JDS 80:1463). The peNDF contents in the diets ranged from 9 to 14% using the PSPS, and were double using the 1.18 mm screen. Higher intakes of peNDF due to higher F:C or longer forage particle size increased chewing time. However, increased intake of peNDF due to grain processing had minimal effect on chewing time. Intakes of peNDF measured by both methods were correlated ($r^2=46$, $P<0.01$) to chewing activity. Mean ruminal pH was lower for cows fed flatly rolled barley than for cows fed coarsely rolled barley with no effect of F:C ratio or forage particle size. No correlation was observed between the intake of peNDF and ruminal pH regardless of the method used. Although contents of ruminal VFA were not affected by the dietary factors measured, the intake of peNDF was correlated positively to acetate proportion ($r^2=52$, $P<0.01$) and negatively to propionate proportion ($r^2=-42$, $P<0.02$). These results indicate that peNDF content of the diet is a reliable indicator of chewing activity and VFA profile but not a good indication of ruminal pH. Both methods (PSPS or 1.18 mm screen) can be used to accurately measure peNDF of feeds fed to dairy cows.

Key Words: Effective Fiber, Chewing Activity, Rumen Fermentation

1751 The effect of copper oxide bolus administration on forage fiber digestibility in growing steers. J. D. Arthington* and W. F. Brown, Range Cattle Research and Education Center, University of Florida, Ona.

The objective of this study was to evaluate the effect of an intra-ruminal bolus containing copper (Cu) oxide needles (Copsure; Animax Ltd.,

Columbus, OH) on forage fiber digestion. Eight steers were randomly assigned to receive either a single bolus of Cu containing 12.5 g of Cu oxide needles (B; n=4) or no bolus (NB; n=4). During the 39-d study all steers were individually offered ground limpgrass hay (8.6 ppm Cu) in quantities sufficient to ensure ad libitum access. On d12 (Period 1; P1) and d33 (Period 2; P2) steers were placed in metabolism crates and total forage offered, refused, and fecal production were collected for 7d. Compositated samples of forage offered, refused and feces for each steer at each period were analyzed for DM, OM, NDF, ADF, and CP. All digestibility results were calculated on an OM basis. Liver biopsy samples were collected on d12 and d33. Cu oxide bolus administration resulted in an increase ($P<0.03$) in liver Cu at the start of P1 (556 vs. 296 ppm) and P2 (640 vs. 327 ppm). Total tract OM digestibility and OM intake expressed as a percentage of BW was not different ($P>0.10$) between treatments for either period. Although total fecal ash production was not different, B steers had increased ($P<0.03$) fecal Cu during P1 (164 vs. 21 mg Cu/d) and P2 (79 vs. 23 mg Cu/d). Fecal aluminum, iron, manganese, and zinc were not different for either period. Intake of NDF and ADF did not differ between treatments for either period; however, digestibility of NDF and CP were higher ($P<0.04$) for NB steers in P2 (62.2 vs. 57.1 and 50.2 vs. 43.4 % for NDF and CP digestibility, respectively). Digestibility of ADF tended to be higher ($P=.092$) for NB steers in P2 (57.3 vs. 52.3 %). These data suggest that although Cu oxide boluses are effective in increasing tissue Cu stores, they may contribute to lower forage fiber digestibility.

Key Words: Copper oxide, Fiber digestion, Steer

1752 Effect of forage particle length on ruminal liquid fraction kinetics and straw degradability of steers fed an oat straw diet. H. G. Gonzalez^{*1,3}, O. B. Ruiz², M. L. De la Vega², A. E. Orozco², A. C. Correa³, A. M. Perez³, V. V. Gonzalez³, H. C. Hernandez⁴, E. T. Rubio¹, and L. B. Gerlach⁵, ¹Medicina Veterinaria y Zootecnia-ICB, Universidad Autonoma de Ciudad Juarez, Mexico, ²Universidad Autonoma de Chihuahua, ³Universidad Autonoma de Baja California, ⁴Universidad Autonoma de Baja California Sur, ⁵Universidad de Sonora.

Four Hereford steers (300 kg) fitted with permanent rumen cannulas were used to evaluate the effect of 2 forage chop lengths: 2.5 cm (T1) and 10 cm (T2) on the ruminal liquid fraction kinetics and straw degradability. The animals were fed a basal oat straw diet and they were provided an alfalfa hay supplement (20%). Alfalfa was offered twice daily at 0800 and 1700 h. The estimation of liquid kinetics was made by using a system of equations. A dose of Co-EDTA was infused into the rumen, and ruminal fluid samples were taken from each animal at 0, 1.5, 3, 6, 9, 12, 16, and 24 h post-infusion. The ruminal degradation of straw was estimated by using the nylon bag technique and a non-linear model. Data was analyzed as a switchback design. The feed intake was *ad libitum*. It was observed a higher DMI ($P<.05$) of T1 than T2 (79.7 vs 70.8 g $kg^{-1} W^{.75}$). No differences ($P>.05$) were detected in ruminal volume (79.93 vs 87.7 L) between diets. Nevertheless, steers fed T1 had a faster ($P<.01$) mean time (9.48 vs 16.02 h), dilution rate (7.08 vs 4.36 % h^{-1}), flow rate (5.64 vs 3.82 L h^{-1}), and turnover rate (1.7 vs 1.04 times d^{-1}) than steers fed T2. No differences were detected in degradation rate. No differences ($P>.05$) were detected in ruminal straw degradation to water soluble fraction (constant a; 19.94 vs 20.22 %), and degradation rate (.0258 vs .0255 % h^{-1}) for T1 and T2 treatments. A significant difference ($P<.05$) was detected in potential degradation of b constant (31.04 vs 33.27 %) between T1 and T2, respectively. These results suggest that size of forage affects the kinetic of liquid fraction and DMI.

Key Words: Steers, Kinetics, Degradability rate

1753 Models for describing kinetics of fiber digestion in the rumen. F. O. Carrete-Carreón*, C. E. Cole, J. H. Matis, W. C. Ellis, and C. Lowe, Texas A & M University.

The objective of this research was to evaluate alternate, non-exponential models for describing the expected distribution of lifetimes in the rumen of undigested, U, potentially digestible NDF and its constituent entities, cellulose and hemicellulose. Models having non-exponential distribution of lifetimes of U were emphasized because of the variable content and rate of digestion of entities that comprise NDF. Four classes of models were evaluated for fit to observed lifetimes for U in the rumen. Types of models included: 1) a single exponential distribution of lifetimes for U (G1), 2) a single distribution of gamma distributed, age-dependent

lifetimes for U (GN where $N \geq 2$), 3) simultaneous distribution of GN and G1 lifetimes for U (GN+G1 and G1+G1) and 4) a heterogeneous distribution of exponential, GN, and other non-exponential distributions of lifetimes (GX) for U. The U in ryegrass (*Lolium perenne* L.) hay, cotton seed hulls, CSH, and a mixed diet of 60% CSH ground to pass a 2 mm sieve was determined in triplicate as the U remaining after 0, 2, 6, 12, 18, 24, 36, 48, 60, 72, 96, 144 and 240 h. *in situ* in two rumen cannulated cattle. Discrete time delays statistically different from zero ($P < 0.05$) were frequently resolved by the G1 model. In contrast, inclusion of non-exponential distribution of lifetimes, GN, or simultaneous distributions of lifetime, G1+G1 and GN+G1, accounted for the spectrum of observed lifetimes of U without a discrete time delay and resulted in superior statistical fit ($P < 0.05$). Models assuming an intermediate age-dependency for a single distribution, G2, or two simultaneous distributions of lifetimes, G2+G1 and G3+G1 yielded mean rates of digestion and estimates of indigestible proportions that were of intermediate magnitude. Differences in mean rate of digestion for cellulose and hemicellulose that comprise NDF substantiate the need for non-exponential distributed models of NDF digestion. The G2+G1 or G3+G1 model were least sensitive to initial starting values and most reliable in achieving convergence and are recommended as better descriptors of the process of digestion of NDF in the rumen.

Key Words: Fiber, Digestion, Models

1754 Rumen fluid dilution rates in cattle grazing tropical pastures. M.K. Bowen^{1,2}, S.R. McLennan¹, and D.P. Poppi², ¹Queensland Beef Industry Institute, Yeerongpilly Australia, ²University of Queensland, St Lucia Australia.

Low rumen dilution rates may contribute to the low efficiencies of microbial crude protein (MCP) production sometimes reported with cattle on tropical pastures. Fractional outflow rates (FOR) were estimated in cattle across a range of tropical pasture types and seasonal conditions in south-eastern Queensland, Australia. Eight rumen-fistulated, *Bos indicus* steers (initial BW 329 ± 26 kg) grazed six tropical pastures over 12 months, including: a native pasture (major species C4 Black speargrass (*Heteropogon contortus*) and Forest bluegrass (*Bothriochloa bladhii*)) in the early wet season (NPEW), dry season (NPD) and wet/dry transitional period (NPT); an introduced C4 pasture species, Creeping bluegrass (*Bothriochloa insculpta* cv. *Bisset* (BB)) in the mid wet season; and the introduced tropical legumes Dolichos lablab (*LabLab purpureus* cv. *Highworth* (LL)) and Butterfly pea (*Clitoria ternatea* cv. *Milgarra* (BP)). The temperate annual ryegrass (*Lolium multiflorum* cv. *Tetila* (RG)) was included for comparison. A single dose of chromium-ethylenediamine tetracetic acid (Cr-EDTA; ca.2 g Cr) was injected into the rumen and nine rumen fluid samples were collected over the next 48 h. There was a three-fold variation in FOR across pasture types, representing a range in marker retention times from 8.6-22.9 h. FOR values for early to mid season C4 grasses were similar to those for C3 species (tropical legumes and ryegrass) but that for mature native C4 pasture (NPD) was very low in association with the very low availability of green leaf. Rumen volume did not show the same variation. The results indicate considerable scope to manipulate dilution rate and potentially the efficiency of MCP synthesis.

| | NPEW | NPT | NPD | BB | LL | BP | RG |
|-----------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|------------|
| Green leaf in pasture (%DM) | 57.4 | 28.7 | 2.9 | 21.8 | 23.3 | 14.1 | 80.0 |
| FOR (%/h) (s.e.) | 10.8 (0.48) | 7.6 (0.36) | 4.5 (0.33) | 9.5 (0.37) | 11.7 (0.44) | 8.4 (0.70) | 9.3 (0.98) |
| Rumen volume (L.100/kg BW) (s.e.) | 10.7 (0.96) | 12.4 (0.51) | 11.0 (1.07) | 10.3 (0.40) | 9.6 (0.68) | 11.3 (0.38) | 9.9 (0.29) |

Key Words: Dilution Rate, Tropical Grasses

1755 The low forage feeding program, Totalac[®], increases milk production in high producing Holstein cows. P.A. Porter*, C.M. Luhman, and D.W. LaCount, Land O Lakes, Inc. and Cooperative Research Farms.

In 3 trials conducted over a 4-year period at one site, a low forage feeding program (25% of the ration DM) for high producing cows was evaluated; the trademarked name for the concentrate portion of these diets is Totalac[®]. The control rations were 50:50 forage: concentrate

ratio. The forage program in each trial was a 1:1 blend on a DM basis of corn silage and alfalfa silage; commercial applications of Totalac[®] have included hay. All treatments were fed to insure 10% feed refusal. Commercial applications have included hay. In Trial 1, a 4x4 Latin Square with 21-day periods, milk production was increased by 1.1 kg/d ($P < .05$) with the low forage program. Milk composition and DM intake were not different. In Trial 2, initiated at 100 DIM with a 15-week feeding period, the low forage program increased milk production by 3.7 kg/day, DM intake by 1.0 kg/day and milk crude protein content by .09% ($P < .05$). In Trial 3, initiated at day 1 of lactation with a 10-week feeding period, milk production and composition and DM intake were similar for control and low forage treatments. These data demonstrate that high producing dairy cows can be successfully fed low forage diets, even in early lactation. Long-term field usage (>300 days) has not indicated any adverse cow health effects. Totalac is registered trademark of Cooperative Research Farms.

| Trial | 1 | 1 | 2 | 2 | 3 | 3 |
|----------------|--------------------|-------------------|-------------------|-------------------|-------|-------|
| Treatments | 50:50 ¹ | 25:75 | 50:50 | 25:75 | 50:50 | 25:75 |
| N/Trt. | 8 | 8 | 21 | 22 | 17 | 42 |
| DMI, kg/d | 24.2 | 24.0 | 22.4 ^a | 23.4 ^b | 19.0 | 20.1 |
| Milk, kg/d | 29.5 ^a | 32.6 ^b | 36.7 ^a | 40.4 ^b | 37.4 | 38.8 |
| 3.5% FCM, kg/d | 30.8 | 30.4 | 33.7 | 32.7 | 39.2 | 39.6 |
| Milk Fat, % | 3.89 | 3.44 | 3.03 | 2.53 | 3.81 | 3.63 |
| Milk CP, % | 3.53 | 3.46 | 3.23 ^a | 3.32 ^b | 3.01 | 3.06 |

^{a,b} Means within a trial and within a row differ at $P \leq 0.05$. ¹ Refers to F:C ratio.

Key Words: Totalac[®], Lactating Cows, Low Forage

1756 Growth rate of buffalo female calves on urea treated low quality roughages. Syed, H. Raza^{*1}, Shahid Mahboob², M.S. Khan¹, and Arshad Iqbal¹, ¹Faculty of Aniaml Husbandry, University of Agriculture, Faisalabad, Pakistan, ²Dept. Zoology, Govt. College, Faisalabad, Pakistan.

Eight buffalo female calves of almost similar age (5.20 ± 0.5 m) and weight (60.1 ± 1.5 Kg) were randomly allotted into two groups (A) and (B), each with four calves. The calves of group (A) were fed on ration containing untreated wheat straw (UWS) that served as control group. The group "B" was fed on ration containing 3% urea treated wheat straw (UTWS) for a period of six weeks in completely randomized design (CRD). The data on dry matter intake (DMI), daily live weight gain (DLWG), feed conversion ration (FCR) and digestibility of different nutrients viz., dry matter, (DM) crude protein (CP), crude fiber (CF), nitrogen free extract (NFE), other extracts (EE) and organic matter (OM) were recorded. The average values for DMI, DLWG, FCR and organic matter intake (OMI) were found to be 1.76 ± 0.65 and 2.63 ± 0.24 , 0.231 ± 0.04 and 0.332 ± 0.01 , 7.61 ± 0.32 and 7.92 ± 0.41 and 1.64 ± 0.06 and 2.42 ± 0.21 kg for treatments "A" and "B", respectively. The unit (%) increase in digestibility for urea treated wheat straw (UTWS) was found 9.51, 8.09, 13.68, 8.35, 12.46 and 10.35% for DM, CP, CF, NFE, EE and OM, respectively. Results suggested that urea treatment of wheat straw caused improvement in feed intake. The improvement in DMI and digestibility of various nutrients was due to the decrease in lignification, increase in N2 contents and more exposure of treated material for microbial attack for digestion breakdown.

Key Words: Buffalo, Growth, Roughages

1757 Utilization of gas production manometric system to estimate the rate of degradation of the dry matter (DM), neutral detergent fiber (NDF) and neutral detergent soluble fraction (NDS) of concentrate feeds by cattle, sheep and goat. J. C. Teixeira* and R. A. Santos, Universidade Federal de Lavras, Minas Gerais, Brazil.

The objective of this trial was to evaluate the degradation rate of the DM, NDF and NDS in ground corn, wheat, soybean and cotton meals, cottonseed and citrus pulp. The feeds were milled through 2.0 mm screen and the samples of 400 mg were incubated in vitro, in buffered rumen fluid obtained from 3 cows, 3 sheep and 3 goats. They were incubated whole sample, residue of neutral detergent. The gas production from NDS fraction was obtained by difference between the cumulative production of DM and NDF. The gas production (volume and pressure)

was measured after incubation time of 1, 2, 3, 4, 5, 6, 12, 18, 24, 30, 36, 48, 60 and 72 h, by manometric system. The volume of gas for all feeds was not different ($P < 0.01$) between cattle, sheep and goat (47.23; 52.18 and 49.56 ml respectively), and any interaction between species and fractions of the feeds was detected ($P > 0.05$). The colonization time of all feeds was not different ($P < 0.01$) between species (2.03; 2.32 and 2.93 h) too, but the NDF fraction had higher value ($P < 0.01$) than DM and NDS fractions (5.15; 1.14 and 0.99 h respectively). There was not difference ($P < 0.01$) between species to degradation rate of the tested feeds. However, the fraction NDS showed the best result ($P < 0.01$) for this variable; 10.54 versus 5.84 and 5.81 %/h to DM and NDF respectively. There was not interaction between fraction and feed ($P > 0.05$). This study shows that cattle, sheep and goat have the same behavior to degrade concentrate feeds. On the other hand, gas production technique is simple, fast and it can be used to estimate the degradation rate of feedstuffs, with success.

Key Words: Gas production, Degradation rate, Concentrate

1758 Comparison of the in vitro gas production and the nylon bag degradability techniques to measure degradation rate in cattle, sheep and goat. R. A. Santos and J. C. Teixeira*, *Universidade Federal de Lavras, Minas Gerais, Brazil.*

A study was conducted to compare in vitro gas production and nylon bag degradability techniques as methods of measuring degradation rate of ruminant feeds, and to determinate whether it is possible to predict in situ DM degradability with the gas production manometric technique. The samples of some roughage and concentrate feeds, were milled through 2.0 mm screen. They were utilized 3 animals of each specie to two techniques. The samples stayed incubated in the rumen for 72 h and the readings of in vitro cumulative gas production were made after incubation time of 1, 2, 3, 4, 5, 6, 12, 18, 24, 30, 36, 48, 60 and 72 h. The Pearson correlation coefficients between each pair of variables from in situ and gas production measurements were obtained using SAS. For all tested feeds there was significant ($P < 0.05$) correlation between in situ effective degradability and the volume of gas to all three species. Similarly, in situ DM disappearance was correlated ($P < 0.01$) with volume de gas. To sheep, the estimates of in situ effective degradability and DM disappearance were correlated ($P < 0.01$) with in vitro degradation rates. It can be concluded that the in vitro gas production is related to the degradation rate estimated by the in situ technique. Besides, the gas production technique with its simplicity of use and the possibility of processing a large number of samples in a short time, it will be important to find significant and valid correlation between in situ degradability and gas production parameters.

Key Words: Gas production, Degradation rates, In situ degradability

1759 The effect of rumen pH and forage type on in situ fiber hydrolysis in dairy heifers. C. Spackman*, R.L. Baldwin, E.J. DePeters, and M.L. Sweany, *University of California, Davis, CA.*

The objectives of this study were to determine the effects of rumen pH and forage type, on fiber hydrolysis in the rumens of Holstein heifers. Rumen and duodenal cannulated pregnant heifers (8) were sequentially fed four unbuffered diets, 100% oat hay (100%O), 40% oat hay:60% concentrate (40%O), 100% alfalfa hay (100%A), and 40% alfalfa:60% concentrate (40%A). Both oat hay (O) diets had a crude protein (CP) of 10% and both alfalfa hay (A) diets a CP of 20%. All animals were housed individually and fed twice a day at 8am and 6pm. After a 14d adjustment period to each diet, filter bags (ANKOM F57) containing samples of ground O or A to match the forage in that diet were incubated in the rumen. Bags were placed in the rumen at morning feeding and removed after 2,4,6,8,10,12,16, and 24h. After removal, bags were washed with water 6 times for 1 min in an ANKOM²⁰⁰ Fiber Analyzer at room temperature. Bags were then frozen until further analysis. Rumen pH was recorded every 15 min during the 24h incubation period by an indwelling pH probe inserted through the rumen cannula housed in the pocket of a harness worn by each heifer. Average pH values over the 24h for the four diets were 6.69, 6.38, 6.62 and 5.93 for 100%O, 40%O, and 100%A, 40%A respectively. A greater difference was seen between diets for range of pH values averaged across animals 5.99 to 7.21, 5.43 to 6.93 for 100%O and 40%O, and 5.88 to 7.11, and 5.13 to 6.79 for 100%A and 40%A. Dry matter (DM) loss from bags containing A incubated in

the rumen for 12h was reduced from 43.8% (100%A) to 33.3% (40%A) in response to concentrate. No difference was seen in the O bags with only 30% DM loss after 12h. Loss of DM from bags containing A rose to 54.9% on 100%A, and to 39.9% on 40%A after 24h. Increasing unbuffered concentrate in the diet resulted in a lower average rumen pH and a reduction in fiber hydrolysis for both forage types. Total fiber hydrolysis over 24hours was more reduced for A than O, suggesting that effect of rumen pH on fiber hydrolysis may vary with forage.

Key Words: pH, Rumen, Fiber

1760 Effects of Dietary Proportions of CP/Potentially Digestible NDF, PDF, upon Rates of Digestion, Turnover and Intake of PDF. C. A. Lowe*, W. C. Ellis, F. O. Carrete-Carreón, C. A. Marsh, and E. Moody, *Texas A & M University.*

It is hypothesized that insufficient yield proportions of rumen degraded CP, RDP, and potentially digestible NDF, PDF, limit the rate of digestion, ruminal turnover and intake of PDF. The objective of this experiment was to investigate effects of a wider range in CP/PDF than observed in previous studies. Three mature cattle with established rumen cannulae were fed mineral supplemented, mature bahia grass (*Paspalum notatum*) hay, *ad libitum*, with 0.0, 0.91, or 2.73 kg/d of cottonseed meal in a three by three Latin square design. Leaf and stem portions of the hay were separated, and labeled with different rare earth elements and consumed with a single meal in order to measure their ruminal turnover rate. Also, leaf and stem samples ground to pass a 2 mm screen were incubated in the rumen of the three cows during each period, for 0, 2, 6, 12, 18, 24, 36, 48, 60, 72, 96, 144 and 168 h *in situ* for determination of mean rate of digestion of PDF. The mean rate of digestion of PDF, PDFkd, was estimated by fitting a two-compartment age dependent, age-independent model to the profiles of undigested NDF *in situ*. PDFkd, for both leaf and stem, did not differ ($P = 0.14$), was unaffected by level of dietary protein and averaged 0.027/h. The mean of turnover rate, ke, did not differ for leaf and stem and was significantly ($P < 0.05$) and positively related to CP/PDF. Daily intake rate of PDF (g PDF/kg BW) was significantly and positively, $P < 0.05$, related to CP/PDF. Treatment means were 7.8^b, 8.6^{ab}, and 9.4^a g PDF/kg BW, for 0.0, 0.91, and 2.73 kg/d of cottonseed meal, respectively. Protein supplementation was not related to rate of *in situ* digestion. Thus, the hypothesized positive effects of dietary CP/PDF upon rates of ruminal turnover and intake of PDF were supported while the tend for positive effects on PDF was a non-significant ($P > 0.05$) trend.

Key Words: Rumen, Protein, Kinetics

1761 Effects of ensiling temperature and enzyme additives on the fermentation and in vitro rumen degradation of maize silage. D. Colombatto*¹, F. L. Mould¹, M. K. Bhat², R. H. Phipps¹, and E. Owen¹, ¹The University of Reading, UK, ²Institute of Food Research, Norwich, UK.

Forage maize (352, 447, 227 and 323 g/kg DM, NDF, ADF and starch, respectively) was ensiled in triplicate in 0.5 kg capacity silos, with or without addition of two enzyme preparations. Depol 40 (D, Biocatalyst Ltd, UK) and Liquicell 2500 (L, Specialty Enzymes and Biochemicals, USA) were added to provide relative xylanase activity levels of 7200, 14400, and 28800 units/kg forage DM. The silos were stored at room temperature (R, 15-20°C) for 120 d, or at 40°C for three weeks, then stored at R. Storage at 40°C decreased ($P < 0.05$) the mean pH of D-treated silages (3.71 vs. 3.47 for R and 40°C, respectively). No differences ($P > 0.05$) in the untreated silages (3.99 vs. 3.98) or in the L-treated silages (3.69 vs. 3.72). Starch contents were reduced ($P < 0.05$) by addition of D (252, 136, 102, and 82; 267, 190, 164, and 94 g/kg DM for control and D-treated silages at R or 40°C, respectively), in line with the high levels of α -amylase found in this preparation. NDF and ADF levels were increased ($P < 0.05$) as a result of starch hydrolysis, but this effect was only evident at R. NDF and ADF contents in L-treated silages were decreased ($P < 0.05$) (492 vs. 394, 249 vs. 198; and 489 vs. 392, 253 vs. 190 g/kg for NDF and ADF of control and L, at R or 40°C). As a result, L-treated silages showed an increase ($P < 0.05$) in starch (252 vs. 339 g/kg DM, and 267 vs. 347 g/kg DM for control and L-treated silages at R and 40°C). In vitro gas production and OMD dynamics were assessed using the Reading Pressure Technique. Rumen fluid was collected pre-feeding (0700 h) from two cows fed a maize silage-based TMR. Initial rates of gas production and OMD were decreased ($P < 0.05$)

in the D-treated silages, but were increased ($P < 0.05$) in the L treatments. End-point OMD was reduced ($P < 0.05$) in all D treatments at R, whereas no differences ($P > 0.05$) were observed at 40°C for any treatment. It is concluded that Liquicell 2500 shows potential to increase the rate of rumen degradation.

Key Words: Maize silage, Enzymes, Temperature

1762 Evaluation of a novel psychrophilic enzyme mixture as a potential additive for maize silage. D. Colombatto^{*1}, F. L. Mould¹, M. K. Bhat², G. Black³, and E. Owen¹, ¹The University of Reading, UK, ²Institute of Food Research, Norwich, UK, ³University of Sunderland, UK.

The fermentation characteristics and in vitro degradation of maize silages were examined to evaluate the effects of addition of a psychrophilic enzyme mixture at ensiling. The enzyme mixture (E) was a crude extract from the bacterium *Flavobacterium xylanivorum*, and contained mainly xylanase activity. Forage maize (335, 461, 219, 354 g/kg DM, NDF, ADF and starch, respectively) was ensiled in triplicate in minisilos, with or without enzyme addition at two levels (10 and 20 ml/kg forage DM, E1 and E2). The silos were stored at room temperature (15-20°C for 210 days. No effects ($P > 0.05$) on silage pH were observed (4.04, 4.13 and 3.96 for control, E1 and E2). NDF and ADF were numerically increased ($P > 0.05$) by E addition (417, 423 and 448 g/kg; 209, 216 and 240 g/kg of NDF and ADF for control, E1 and E2), whereas starch contents appeared to decrease with the highest level of addition (388 vs. 352 g/kg DM). In vitro gas production and OMD dynamics were assessed using the Reading Pressure Technique. Rumen fluid was collected pre-feeding (0700 h) from a cow fed on a maize silage-based TMR. Gas pressure measurements were taken 14 times over the incubation period, and sets of treatments were removed in triplicate after 6, 12, 19, 24, 48 and 96 h incubation, to determine OMD. No differences ($P > 0.05$) were detected in the rates of gas production, whereas initial OMD (6 h) was increased ($P < 0.05$) with E1 (174 vs. 202 g/kg for control and E1), but decreased ($P < 0.05$) with E2 (174 vs. 162 for control and E2). End-point OMD (96 h) was unaltered by E1 (774 vs. 480 g/kg for control and E1) but decreased ($P > 0.05$) by E2 (774 vs. 750 g/kg). If confirmed in vivo, the observed increased rate of silage OMD treated with this enzyme could lead to an increase in DM intake. However, over-treatment of silages may result in a decrease of the resultant nutritive value.

Key Words: Maize silage, Psychrophilic, Enzyme

1763 Effect of ensiling, storage time and inoculant use on amino acid composition of alfalfa silage preserved in silage bags. S. P. Crosby^{*1}, J. Zmich¹, R. A. Patton², M. J. Stevenson³, and R. T. Ward⁴, ¹Finger Lakes Nutrition, Genoa, NY/USA, ²Nittany Dairy Nutrition, Mifflinburg, PA/USA, ³Degussa-Huls Canada, Burlington, Ont/Canada, ⁴Cumberland Valley Analytical Services, Maudsenville, MD/USA.

Previous work had suggested that during ensiling of alfalfa lysine and arginine were destroyed to a larger degree than other amino acids. To investigate this, fresh alfalfa from two farms in New York state was sampled immediately before storing in silage bags. Ensiling management on these farms was excellent. Corresponding samples were obtained at feed out. A silage inoculant (Biotol Plus II, Biotol Inc) was added at the rate of 120,000 CFU per gram of wet forage. Sampling was based on field, day of cutting and inoculant use. Ten grab samples were mixed and a sub-sample sent to the laboratory for analysis. Nutrient analyses were performed and amino acid content was determined. In all 34 samples (14 inoculated) were analyzed. Effects of fermentation and correlation between wet and ensiled nutrients were evaluated using Proc GLM of SAS with farm and fermentation as factors. Effects of storage time and inoculation were evaluated using Proc Mixed of SAS with fresh values as covariate. Addition of silage inoculant resulted in statistically higher energy (TDN 59.4 vs 60.8, $P < .05$) because of lower fiber values (ADF 35.1 vs 33.3, $P < .02$) but had no effect on protein fractions except for preserving lysine (4.01 vs 4.38, $P < .08$) and arginine (2.08 vs 2.74, $P < .01$). Main effects (ls means) of ensiling on protein fractions is presented below. We conclude amino acid losses under conditions of good ensiling practice appear to be minimal with the exception of arginine.

| Nutrient | Fresh | Ensiled | P | % Change |
|-----------------|-------|---------|-----|----------|
| CP | 22.2 | 21.3 | .01 | -4.05 |
| Available P | 20.9 | 20.0 | .01 | -4.31 |
| Unavailable P | 1.30 | 1.27 | .46 | -2.31 |
| NDF-P | 2.92 | 2.27 | .03 | -22.26 |
| MET % CP | 1.27 | 1.34 | .02 | 5.51 |
| LYS % CP | 4.43 | 4.14 | .01 | -6.55 |
| LEU % CP | 6.15 | 6.27 | .42 | 1.95 |
| ILE % CP | 3.56 | 3.79 | .01 | 6.46 |
| VAL % CP | 4.82 | 5.09 | .01 | 5.60 |
| THR % CP | 3.90 | 3.64 | .01 | -6.67 |
| ARG % CP | 3.60 | 2.32 | .01 | -35.56 |
| HIS % CP | 1.73 | 1.54 | .01 | -10.98 |
| PHE % CP | 4.12 | 3.80 | .01 | -7.77 |
| Total AA %DM | 16.2 | 14.8 | .01 | -8.64 |
| Total Essen %DM | 7.7 | 7.0 | .01 | -9.09 |
| Total Essen %CP | 33.6 | 31.9 | .02 | -5.06 |

Key Words: Haylage, Arginine, Amino acids

1764 Effect of added degradable intake protein on *in situ* and *in vivo* digestibility of processed and unprocessed corn silage fed to beef steers. C.W. Hunt¹, L.R. Kennington^{*1}, G.T. Pritchard¹, J.I. Szasz¹, and W. Mahanna², ¹University of Idaho, Moscow, ²Pioneer Hybrid International, Des Moines, IA.

An experiment with a 2 x 2 factorial arrangement of treatments tested the main effects and interactions of mechanical processing (P+ or P-) of corn silage and DIP level as modified by urea (U+ or U-) on *in situ* and *in vivo* digestion. Treatments were evaluated using four ruminally and duodenally cannulated Angus steers in a 4 x 4 Latin square design. Diets contained 60% corn silage (DM basis) with the remainder being alfalfa hay; 0.5% urea replaced alfalfa in U+ treatments. The level of urea was determined using the 1996 Beef NRC Model to ensure adequate degradable intake protein. Steers were adjusted to silage-based diets for four weeks, then placed on treatment diets for 10-d followed by a 4 d collection period. Chromic oxide was used as an external digestibility marker. Ruminal NH₃ levels were higher ($P < .01$) for U+ than U- diets (13.2 vs. 8.9 mg/dL). Ruminal *in situ* incubations were for 24 and 72 h. No treatment differences ($P > .10$) were observed for OM intake or digestibility. Starch digestibility was greater ($P < .10$) for P+ than P- corn silage (98.6 vs. 96.5%). Urea increased NDF digestibility of P- diets (57.9 vs. 54.6%), but decreased NDF digestibility in P+ diets (53.4 and 56.5%; processing x urea, $P < .05$). Starch degradation *in situ* was greater ($P < .05$) at 24 h for P+ than P- silage (87.4 vs. 66.5%) with no differences ($P > .10$) observed at 72 h. Degradation of NDF was greater ($P < .05$) at 24 and 72 h for P- than P+ corn silage (22.1 vs. 28.4% and 47.8 vs. 50.7%, respectively). The increase in starch degradation in the first 24 h may partially explain the decreased NDF degradation in the P+ silage. Results indicate that improved ruminal starch degradability achieved from mechanical processing is detrimental to NDF degradation, and this effect is not corrected with additional DIP.

Key Words: Corn Silage, Digestibility, Starch

1765 Interactions of corn silage particle size and tallow supplementation on rumen fermentation and performance of dairy cows fed corn silage-based diets. S. G. Onetti^{*}, R. D. Shaver, and R. R. Grummer, *University of Wisconsin-Madison*.

In a previous study (Onetti et al., J. Dairy Sci. 83 (Suppl. 1):277) we showed that including 2% tallow in corn silage-based diets has negative effects on production and rumen fermentation of high producing dairy cows. The objective of this study was to determine if the length of chop of processed corn silage influences the impact of supplemental fat on rumen fermentation and performance of dairy cows. We hypothesized that increasing forage particle length may alleviate the interference of fat on rumen fermentation. Sixteen Holstein cows averaging 120 DIM were used in a replicated 4 x 4 Latin square design with 21d periods. Treatments were arranged in a 2 x 2 factorial design with 0% or 2% tallow (DM basis), and corn silage harvested at either 1.9 cm or 3.2 cm theoretical length of cut. The forage:concentrate ratio was 50:50, and diets were formulated to contain 18% CP and 32% NDF (DM basis). Cows were allowed ad libitum consumption of diets that were fed twice daily as a TMR. Fat supplemented cows had lower DMI and produced less milk fat relative to non-supplemented cows. No effect of silage particle

length was observed for DMI and milk fat production. Milk production tended to be higher for cows consuming short-cut silage without supplemental fat. Rumen pH was not affected by supplemental tallow, and tended to be higher for cows eating long-cut silage. No effect of treatments was observed for rumen ammonia concentration. In this study, tallow supplementation had a negative impact on performance of dairy cows regardless of the corn silage particle length.

| | 0% Tallow | | 2% Tallow | | Significance ($P < .05$) ¹ | | F _{xL} |
|-------------------------|-----------|------|-----------|------|---|------|-----------------|
| | 1.9 | 3.2 | 1.9 | 3.2 | F | L | |
| Corn silage, cm | 1.9 | 3.2 | 1.9 | 3.2 | F | L | F _{xL} |
| DMI, kg/d | 26.7 | 26.5 | 25.0 | 25.0 | 0.001 | NS | NS |
| Milk, kg/d | 42.4 | 40.7 | 40.5 | 40.9 | NS | NS | 0.11 |
| Fat, % | 2.92 | 3.02 | 2.71 | 2.72 | 0.001 | NS | NS |
| Fat, kg/d | 1.23 | 1.23 | 1.10 | 1.10 | 0.001 | NS | NS |
| pH | 6.06 | 6.15 | 6.13 | 6.24 | NS | 0.09 | NS |
| NH ₃ , mg/dl | 14.7 | 15.2 | 17.1 | 14.8 | NS | NS | NS |

¹F = main effect of fat, L = main effect of length of cut, F_{xL} = interaction

Key Words: Tallow, Corn silage and particle size, Rumen fermentation and milk fat

1766 The effect of ensiling whole plant corn and wet corn gluten feed simultaneously on silage fermentation. J.A. Mills* and R.J. Grant, *University of Nebraska, Lincoln NE.*

The objective of this study was to evaluate the effect of corn silage combined with graded levels of wet corn gluten feed on silage fermentation in laboratory silos. Six combinations were ensiled in triplicate in micro silos for 37 d. Treatments were corn silage with wet corn gluten feed (WCGF) replacing 0, 20, 40, 60, 80, or 100% of the corn silage (DM basis). The treatment containing 0% wet corn gluten feed was designated as the control. Samples were collected before and after ensiling to determine ensiling characteristics and forage quality. The initial pH of control was highest ($P < 0.05$) at 6.02, and decreased with increasing levels of WCGF (3.91 for 100% WCGF). Packing density increased linearly with addition of WCGF (238 to 611kg/m³, DM basis). Prior to ensiling, water-soluble carbohydrate concentrations averaged 9.4% of DM for all treatments. Ammonia-nitrogen concentration increased (0.04, 0.06, 0.06, 0.09, 0.09, and 0.10% of DM) as did crude protein (9.1, 12.6, 12.8, 18.8, 21.1, and 22.5%) with increasing WCGF. The NDF percentage decreased with addition of WCGF (44.2, 39.2, 38.9, 38.1, 36.3, and 37.8% of DM) to corn silage. After ensiling, pH ranged from 3.87 (control) to 4.16 (40% WCGF). Water-soluble carbohydrates utilized during ensiling decreased with increasing amount of WCGF (8.8, 8.6, 8.4, 6.3, 3.2, and 1.9% of DM). Ammonia-nitrogen concentrations were lowest (0.085% of DM, $P < 0.05$) in the control silage; however, ammonia-nitrogen showed the greatest increase when compared with the initial concentration (50%). Dry matter recovery ranged from 86.7 (20% corn silage) to 96.2 (100% WCGF). In vitro NDF digestibility was greatest ($P < 0.05$) at 60% WCGF (60.7%) and lowest at either 100% WCGF (41.2%) or 100% corn silage (44.9%). Addition of wet corn gluten feed to whole plant corn at ensiling had no negative effects on corn silage fermentation and has the potential to be a suitable way to increase packing density in the silo for corn silage.

Key Words: Corn silage, Wet corn gluten feed, Silage quality

1767 Fermentation characteristics of alfalfa hay harvested at different stages of maturity and cutting times in continuous cultures of rumen contents. H. Han*¹, H. S. Hussein¹, J. P. Tanner¹, and H. F. Mayland², ¹University of Nevada-Reno, Reno, NV, ²USDA-ARS, Kimberly, ID.

This study was designed to investigate the ruminal fermentation characteristics of first harvest (1998) alfalfa hay as influenced by the stage of maturity and cutting time. Eight dual-flow continuous culture fermenters were used in an incomplete block design experiment. Nine alfalfa hay substrates were evaluated in four experimental periods (blocks; 8 d each with 5 d for adjustment and 3 d for sample collection) to allow for 3 replications for each treatment. The treatments were arranged as a 3 × 3 factorial. The main factors were 3 stages of maturity (i.e., vegetative, early bud, and 1/10 bloom) and 3 times of cutting (600, 1500, and 2100). The CP content averaged 23.3, 21.6, and 15.5 % (DM basis) for

the vegetative, early bud, and 1/10 bloom stages, respectively. No interactions ($P > .05$) were detected for any of the measurements evaluated. Cutting time did not affect ($P > .05$) OM digestion, N metabolism, or VFA concentrations. The following table summarizes the effects of stage of maturity on ruminal fermentation of the hay. Results suggested that time of cutting alfalfa had no effect ($P > .05$) on ruminal OM fermentation or N metabolism. Despite the highest ruminal degradation of alfalfa CP at the vegetative stage, results indicated greater amounts and higher efficiency of ruminal bacterial protein synthesis at this stage of maturity. Therefore, ruminants may utilize nutrients in alfalfa hay at higher efficiency if it is cut at earlier stages of maturity.

| Item | Vegetative | Early bud | 1/10 Bloom | SEM |
|--|-------------------|--------------------|-------------------|------|
| True OM digestibility, % | 58.4 | 57.5 | 56.4 | 2.4 |
| N intake, g/d | 3.42 ^a | 3.21 ^b | 2.48 ^c | .004 |
| Effluent bacterial N, g/d | 1.70 ^a | 1.46 ^{ab} | 1.22 ^b | .09 |
| CP degradation, % | 92.7 ^a | 83.4 ^{ab} | 75.3 ^b | 3.7 |
| Bacterial synthesis, g N/kg | | | | |
| OM truly digested | 43.3 ^a | 37.5 ^b | 31.7 ^c | 1.3 |
| Effluent NH ₃ -N, mg/100 ml | 48.3 ^a | 41.0 ^b | 24.9 ^c | .7 |
| Total VFA, mM | 93.0 ^a | 87.4 ^b | 81.7 ^c | 1.3 |

Key Words: Continuous culture, Alfalfa hay, Stage of maturity

1768 High oil corn silage versus typical corn silage for cows early in lactation. J. G. Linn¹, D. G. Johnson¹, J. M. Akayezy¹, F. N. Owens*², D. W. Rice², B. L. Smith², and M. A. Hinds², ¹University of Minnesota, St. Paul, MN 55108, ²DuPont Specialty Grains, Des Moines, IA 50322.

To test effects of corn silage source on milk production and composition, 45 cows (24 multiparous and 21 primiparous) were fed one of three diets (46% corn silage) for 112 days starting 3 days after calving. Diets included 1) normal corn silage (C), 2) high oil corn silage (HO), and 3) C with 1.4% tallow added to the diet at feeding time (CT). Yield of dry matter (Mt/ha) was 45.9 for high oil corn silage and 38.1 for typical corn silage; starch was slightly less (18.2 vs 18.6% of DM) but ether extract was greater for the high oil corn silage (4.0 vs 3.1% of DM). Diet ether extract averaged 3.5, 3.9, and 4.8% of DM for C, HO, and CT diets. Dry matter intake was 11.1% greater for the HO diet. Apparent digestibility of most nutrients did not differ significantly between treatment groups, but fat digestibility was increased ($P = 0.10$) by adding tallow to C (77.2 vs 72.9%). Total milk yield and fat corrected milk production were numerically (2.2 and 5.0%), but not statistically, greatest for cows fed the HO diet (36.4, 38.3, and 36.8 kg FCM/d for C, HO, and CT diets). Fat concentration and yield both tended to be higher (3.7 and 6.5%) for cows fed HO; milk protein concentrations and yields were lowest for cows fed C (1.18, 1.23, and 1.23 kg protein/d with C, HO, and CT diets). Persistency of milk production, based on regression of milk production from day 60 to 105, tended to be greater for cows receiving more ether extract (monthly declines of 10.1, 7.3, and 7.4% for C, HO and CT diets). Compared with milkfat from cows fed CT, concentrations of short-chain fatty acids (C6 through C15) were higher in milkfat from cows fed the C and HO diets. Trans- and cis-18:1 levels were higher in milkfat from cows fed CT than for cows fed C. Milk fat produced by cows fed CT had more CLA (0.55, 0.64, and 0.84% CLA for C, HO, and CT diets). Feed intake and milk production persistency tended to be enhanced by substituting high oil corn silage for typical corn silage.

Key Words: High oil corn, Milk production, Milk composition